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Art. XXXI.—*The Climate of San Francisco for the year 1855*; by H. Gibbons, M.D.

In the following observations the temperature is stated at sunrise, 9 A. M., noon, and 10 P. M. This is not critically accurate in regard to the observations at sunrise and noon. A thermometrograph was used for the former, by which the lowest degree is noted, occurring generally a short time before sunrise. The "noon" observation was made at the warmest period of the day, varying from 12 to 2 or 3 P. M.

Towards the close of the year 1854, the miners and the farmers throughout the State were in trouble for want of rain. On the last day of December, the whole amount of rain fallen since the summer was only 2·60 inches, and nearly all of this was in October. But on December 31st set in a storm which changed the prospect. One third of an inch fell on that day, and the new year was ushered in by the most violent gale witnessed for a number of years. The wind was from the south, accompanied with heavy rain. It is worthy of note that this storm was felt in all parts of the State, in a range of five or six hundred miles north and south, at the same hour—a remark that will apply generally, as far as I can ascertain, to the southerly or southeasterly rainstorms of California. Houses were unroofed or prostrated and trees uprooted at San Francisco, and in the mining regions of the northern counties, a few hours before day light on the 1st of January. The storm was brief, the wind changing

to west before sunrise, and bringing showers of rain and hail through the day.

The first week of January was cold and rainy. On the 6th the mercury fell to 33°, the coldest weather of the entire winter. Snow was visible on the coast mountains. For the remainder of the month the sky was almost cloudless, and the temperature moderate, ranging from 49° to 59° at noon, until the 20th, after which the range was from 60° to 72°—the highest point reached by the thermometer in January since the commencement of my observations in 1850. The warmest morning in the month was 57° and the coldest noon 48°. The mean temperature at sunrise was 44°·71, at 9 A. M. 49°·39, at noon 57°·29, at 10 P. M. 46°·87. Mean of extremes 51°·00. Proportion of clear sky 69 per cent. Thirteen days were entirely or nearly clear, and five entirely cloudy. Four foggy mornings. Rain fell on nine days, quantity 4·52 in. Winds NW and N nineteen days, NE and E one day, SE and S seven days, SW and W four days. Land winds 65 per cent., sea winds 35. High winds on two days. Light breezes on twenty-nine days.

Mean of barometer: sunrise 29·869 in., 9 A. M. 29·885 in., noon 29·860 in., 10 P. M. 29·867 in. Maximum 30·12 in., minimum 29·40 inches.

February, as usual, was warm and agreeable, and mostly dry until the last week. The night temperature ranged generally from 45° to 52°, and the noon temperature from 60° to 70°. One or two slight frosts occurred. The winds were very light, seldom rising above a moderate breeze. They prevailed from N and NW, and South. On the 19th and 20th a brisk gale from the north swept over the entire State, attended with a falling barometer, and followed by heavy rains, which by this time were much needed. An unusual quantity fell, for this month. The thermometrical means were, at sunrise 50°·25, 9 A. M. 55°·04, noon 63°·29, 10 P. M. 52°·32. Mean of extremes 56°·77—being the warmest February for five years. The maximum was 72°, and the minimum 41°. Warmest morning 56°, coldest noon 56°. Proportion of clear sky 60 per cent. Whole days clear thirteen, cloudy five. Fog on two mornings and one evening. Rain on nine days; quantity 4·64 in. Winds N and NW ten days; NE and E two days; SE and S nine days; SW and W seven days. Land winds 44 per cent, sea winds 56. Barometric means, sunrise 29·849, 9 A. M. 29·857, noon, 29·836, 10 P. M. 29·850. Extremes 30·06 and 29·48.

March.—Mean temperature at sunrise 51°·77, 9 A. M. 57·81, noon 67°·03, 10 P. M. 53°·68. Mean of extremes, 59°·40. Highest temperature 78°, lowest 44°. Warmest morning 57°, coldest noon 59°. Proportion of clear sky 53 per cent, cloudy 47. Only seven days were clear from morning to night, and four were

cloudy throughout. Rain fell on twelve days, quantity 4·31 in.; mist on four mornings and one evening. Wind N and NW eight days, NE and E one day, SE and S nine days, SW and W thirteen days. Moderate breezes prevailed and there were no high winds. The month was remarkably warm, being five or six degrees above the average for a number of years past. There were several slight frosts, but not to impede the growth of vegetation. The general range of the thermometer at noon was from 64° to 70°, and on five days it rose above the latter figure. The rainy temperament of the last week of February was continued through the first two weeks of March, and was succeeded, in accordance with the habits of our climate, by a period of perfectly dry weather, lasting a fortnight. Copious rains again fell on the 30th and 31st. The streams in the interior were much swollen about the 6th.

Barometric means: sunrise 29·828, 9 A. M. 29·835, noon 29·791, 10 P. M. 29·828. Maximum 29·99, minimum 29·50

April.—Mean temperature at sunrise 50°·57, 9 A. M. 57°·43, noon 64°·90, 10 P. M. 51°·83. Mean of extremes 57°·73. Highest temperature 78°, lowest 40°. Warmest morning 57°, coldest noon 56°. Proportion of clear sky 63 per cent, cloudy 37. Whole days clear ten, cloudy three. Rain on ten days, quantity 5·59 in. Slight mist on two mornings. Wind NW and N eight days, NE and E one day, SE and S five days, SW and W sixteen days. Land winds 30 per cent, sea winds 70. In this month the sea breeze commences. Several of the afternoons were windy, and twice the wind was high. The temperature was rather below the usual mean for April. The nights commonly ranged from 46° to 55°, and the noonday temperature from 62° to 70°. There was a general white frost on the morning of the 2nd. A greater quantity of rain fell than in any other month of the year. From the 10th to the 17th every day was more or less rainy, but in all the rest of the month there were but two days on which rain fell, and then in very small quantity. About the middle of the month the streams in the interior were much swollen. Lightning was observed on the 11th and distant thunder on the 15th.

Barometric mean at sunrise 29·853 in., at 9 A. M. 29·861, at noon 29·859, at 10 P. M. 29·860. Extremes 30·17 and 29·47.

May.—Temperature at sunrise 50°·06, 9 A. M. 57°·84, noon 65°·37, 10 P. M. 52°·10. Mean of extremes 57°·72. Maximum 83°, minimum 44°; range 39°. Warmest morning 57°, coldest noon 61°. Proportion of clear sky 74 per cent, of cloudy 26. Whole days clear thirteen, cloudy two. Rain on five days; quantity 2·14 in.; mist on one morning and one evening. Wind NW and N five days; NE and E 0; SE and S three; SW one; W twenty-two. High winds on five afternoons, and the after-

noons of sixteen other days windy. Land winds 16 per cent, sea winds 84. The temperature of the month was about the usual standard for May, though the extreme of 83° was uncommon. Slight frosts occurred on several mornings. The general range of the thermometer at sunrise was from 46° to 54°, and at noon from 62° to 68°. May is the transition month from the rainy season to that of permanent drought. A few light rains generally occur, but the quantity in 1855 was far beyond the ordinary supply. Nearly 1¼ inches fell on the 14th and four-tenths on the 19th and 20th, after which there was no more till Autumn.

Barometric means; sunrise 29·835 in.—9 A. M. 29·840,—noon 29·832,—10 P. M. 29·830. Extremes, 30·05 and 29·67.

June.—Mean temperature at sunrise 52°·00, 9 A. M. 61°·20, noon 67°·87, 10 P. M. 54°·40. Mean of extremes 59°·93. Maximum 82°, minimum 49°; range 33°. Warmest morning 57°, coldest noon 62°. Proportion of clear sky 87 per cent, of cloudy 13. Whole days clear nineteen, cloudy 0. No rain. Mist on ten mornings and six evenings. Wind SE and S two days, SW one day, West twenty-seven days. On twenty-two days the afternoons were windy, and on six of these the wind was high. On the 11th, 12th and 13th rains fell in the interior and northern counties. There was a very large proportion of fair weather and cloudless sky. The temperature observed the ordinary range for June, varying mostly from 50° to 54° at sunrise and from 63° to 70° at noon. Land winds 2 per cent, sea winds 98 per cent, or in other words there was almost no land wind.

Barometric means: sunrise 29·701 in., 9 A. M. 29·709, noon 29·706, 10 P. M. 29.695. Extremes 29·98 and 29·57.

July.—Mean temperature sunrise, 54°·90, 9 A. M. 61°.87, noon 67°·45, 10 P. M. 56°·71. Mean of extremes 61°·13. Maximum 90°, minimum 51°; range 39°. Warmest morning 64°, coldest noon 62°. Proportion of clear sky 61 per cent, of cloudy 39. Whole days clear ten, cloudy one. Mist on thirteen mornings, and ten evenings. Wind SE and S one day; SW three days; West twenty-seven days. Proportion of land winds 2 per cent, of sea winds 98 per cent. Windy afternoons twenty-four, of which three high winds. The general range of temperature at night was from 53° to 58°, and at noon from 62° to 70°. On one day, the 7th, it reached the extraordinary height of 90°. The warmest day next to this was 77°. There were but five days in all the month when the mercury rose as high as 70° at noon.

Barometric means for July: sunrise 29·738 in., 9 A. M. 29·750, noon 29·747, 10 P. M. 29·734. Extremes 29·86 and 29·59.

August.—Mean temperature at sunrise 55°·32, at 9 A. M. 63°·23, at noon 69°·61, at 10 P. M. 57·77. Mean of extremes 62°47. Maximum 79°, minimum 53°; range 26°. Warmest morning

57°; coldest noon 64°. Proportion of clear sky 77 per cent, of cloudy 23. Whole days clear sixteen, cloudy 0. Mist on three mornings and four evenings. No rain. On twenty-four days the afternoon was windy, and on three of these the wind was high. Wind SE and S three days, West twenty-eight days. Proportion of sea winds 100 per cent—that is to say the wind did not blow from the land for a single hour during the month. On the night of the 18th there was distant lightning, and on the 19th rain fell in Sierra county. The temperature was slightly above the mean of August for a series of years. At sunrise the mercury ranged between 54° and 57°, with a solitary exception when it stood at 53°. At noon the range was usually between 66° and 74°. On sixteen days the temperature at noon was at or above 70°, which can seldom be said of any month of the year at San Francisco. On the last day of the month was a slight frost in favorable situations, enough in some places to injure the tender vegetables.

Barometric means for August: at sunrise 29·727 in., at 9 A. M. 29·740, at noon 29·739, at 10 P. M. 29·728. Extremes 29·90 and 29.56.

September.—Mean temperature sunrise 54°·97, 9 A. M. 62°·50, noon 69°·90, 10 P. M. 57°·04. Mean of extremes 62°·43. Maximum 84°, minimum 50°; range 34°. Warmest morning 61°, coldest noon 63°. Proportion of clear sky 80 per cent, of cloudy 20. Whole days clear twelve, cloudy 0. No rain. Mist on seven mornings and nine evenings. Wind S and SE three days, SW two days, West twenty-four days, NW one day. Proportion of land winds 3 per cent, of sea winds 97 per cent. There were twelve windy afternoons, on five of which the wind was high. It is unusual to have high sea winds so late in the season. The range of temperature at sunrise was generally from 53° to 58°, and at noon from 64° to 78°, though on three days it rose above 80°. There is usually some rain in September, but none fell in the present month. In Oregon the first rain of the season was on the 3d, and heavy rains fell in the northern counties of California on the 16th and 17th. On the evening of the latter day, lightning was observed from San Francisco in the northern horizon.

Barometric means for September: sunrise 29·718 in., 9 A. M. 29·734, noon 29·727, 10 P. M. 29·677. Extremes 29·85 and 29·60.

October.—Mean temperature at sunrise 54° 77, at 9 A. M. 61°·14, at noon 68°·32, at 10 P. M. 57°·00. Mean of extremes 61°·55. Maximum 79°, minimum 51°; range 28°. Warmest morning 58°, coldest noon 61°. Proportion of clear sky 68 per cent, of cloudy 32; whole days clear ten, cloudy two. No rain. Mist on ten mornings, and seven evenings. Wind SE and S five days, SW one day, West twenty-four days, NW one day. Proportion

of land winds 3 per cent, sea winds 97. The sea breeze always loses its force in this month, though it is apt to recur every afternoon with great regularity, as in the present instance. On eight days the afternoons were windy, but there were no high winds. The general range of temperature was from 52° to 58° through the night, and from 62° to 72° at noon. It was at or above 70° on eleven days.

Barometric means for October: sunrise 29·780 in., 9 A. M. 29·799, noon 29·751, 10 P. M. 29·778. Extremes, 29·95 and 29·59.

November.—Mean temperature at sunrise 46°·60, at 9 A. M. 55°·73, at noon 59°·20, at 10 P. M. 49°·37. Mean of extremes 52°·90. Maximum 67°, minimum 42°; range 25°. Warmest morning 58°, coldest noon 52°. Proportion of clear sky 70 per cent, of cloudy 30. Whole days clear eleven, cloudy two. Rain on seven days, quantity 1·15 in. Mist on five mornings and three evenings. Wind N and NW nine days, NE and E one day, SE and S seven days, SW and W thirteen days. Proportion of land winds 33 per cent, sea winds 67. Two days windy in part, and no high winds. A gale from north took place on the 2nd, extending over the State as do these northers in common, and portending rain, the barometer almost invariably falling during a strong north wind. The first rain was a shower on the 10th, after which several moderate rains were thankfully received, but the ground did not become wet enough for tillage till December. In the early part of the month were several white frosts, and there was also more or less frost nearly every morning after the 12th, the mercury ranging at sunrise during the latter period from 42° to 46°. At noon the general range was from 54° to 64°.

Barometric means for November: sunrise 29·862 in., 9 A. M. 29·879, noon 29·860, 10 P. M. 29·855. Extremes 30·16 and 29·50.

December.—Mean temperature at sunrise 43°·32, at 9 A. M. 47°·58, at noon 52°·19, at 10 P. M. 45·90. Mean of extremes 47°·76. Maximum 61°, minimum 29°; range 32°. Warmest morning 54°, coldest noon 41°. Proportion of clear sky 55 per cent, of cloudy 45. Whole days clear ten, cloudy eight. Rain on fourteen days, quantity 5·45 in. Mist on three mornings and two evenings. Wind N and NW seven days, NE and E six days, SE and S ten days, SW and W eight days. Proportion of land winds 42 per cent, sea winds 58. Parts of three or four days were windy, and there was one high wind accompanied with rain, from SW. This was as unpleasant a month as our climate can supply. The rains were mostly cold and in small quantities, and the sky almost constantly overcast. On the 7th was the very rare phenomenon of a genuine thundergust, arranged much in the style of the Atlantic States, and accompanied

with a shower of hail. After the 23d the air was remarkably cold, the lowest point reached by the mercury being 29°, on the morning of the 24th. At noon it was 41°, with ice in the shade all day. After this, it was at or below the freezing point on five mornings, and during the last week of the month the ground continued frozen in the shade. In December 1850 the thermometer fell to 28°, and in January 1854 to 25°, but the last eight days of December 1855 had a lower mean temperature than any other similar period since the commencement of my observations in 1850. The mountains of the Coast Range in the southeast were seen covered with snow, and snow fell to a great depth in the northern counties.

Summary for the year 1855.—The mean temperature of the whole year was as follows: at sunrise, 50°·771, at 9 A. M. 57°·563, at noon 64°·368, at 10 P. M. 52°·916. The mean of the extremes, which represents the temperature of the year, was 57°·57, which coincides, it may be said *precisely*, with the mean temperature at 9 A. M. This appears to be nearly the mean temperature of our climate, as the following figures for five years will show:

Mean temperature	of	1851,	56°·573
"	"	" 1852,	56°·537
"	"	" 1853,	58°·125
"	"	" 1854,	57°·209
"	"	" 1855,	57°·570
"	"	for five years	57°·203

December was not only the coldest month in the year, but the coldest within the range of my record, which extends back to the winter of 1850–51. The month of January, 1854, comes next in order, and then December, 1850. After the middle of January, the sun acquires sufficient power to raise the temperature very materially. Hence February is never a cold month, and April is sometimes as warm as July. The autumn months are the warmest of the year, the cold sea breeze at that season declining in force. In 1855, the warmest month was August; next comes September, then October, then July, then June, and then March.

The extreme heat of the year was 90°. The mercury has at no time in the course of my observations reached this elevation, except in September, 1852, when it stood at 97° and 98° respectively on two consecutive days. In the whole interior of the state, beyond the immediate influence of the ocean winds, this is a common temperature, and indeed much below the extreme heat of summer. Whenever such weather occurs at San Francisco, it is by a suspension of the ordinary programme, the sea-breeze holding off and allowing the climate of the interior to invade its domain. In some years the extreme heat at San Francisco is not

above 84°. To what extent we are wont to suffer from heat in this latitude of 37½ degrees, may be determined from the fact that in the year 1855, the mercury rose to 80° or above, only on six days. In 1851 it reached that point on nine days, in 1852 on fourteen days, in 1853 on eleven days, and in 1854 on twelve days. More than one half of these warm days were in the autumn, and less than one third in the summer months.

The greatest degree of cold in 1855, was 29°, and the mercury was at or below the freezing point on six days, all of which were in December. It was below 40 on ten days, three of which were in January, and seven in December. In some winters there is no freezing weather, and the most tender plants may bloom in the gardens from season to season. The lowest temperature on my record is 25°,—in January 1854. Next to this 28°, in December 1850, and next, 29° in December 1855. In the year 1853 the mercury did not fall below 40°. The whole number of freezing mornings in 1850 was two, in 1851 one, in 1852 none, in 1853 none, in 1854 three, in 1855 six. The coldest noonday in 1855 was 41°. In December 1850 there was one day when the noon temperature was 38°, and in January 1854, a day when it rose no higher than 37°. Such weather however is extraordinary, and when it occurs every body declares the like was never before known, and that the climate is changing in deference to the American population.

The warmest morning in the year was 64°. The warmest morning for the last five years was 66°. There are but one or two mornings in the year which approach this figure. A sultry night is unheard of. A single night that could be called warm has happened in five years, and then the thermometer was 76° at 10 P. M. and 66° next morning.

The range of the thermometer in 1855 was 61°. In 1851 the range was 54°; in 1852, 63°; in 1853 48°; in 1854, 62°.

The greatest barometric pressure in the year was 30·16 in., the lowest 29·40 in. Range 0·76 in.,—which is nearly the mean range for a series of years. The lowest point reached in five years was 29·20 in.,—during a violent southerly storm.

The time occupied by the various winds is thus represented:

Land winds,		NW	33	days.	Sea winds,		SE	16 days.
"	"	N	25	"	"	"	S	48 "
"	"	NE	11	"	"	"	SW	17 "
"	"	E	1	"	"	"	W	204 "
Total land winds,			80	"	Total sea winds,			285 "

It may be well to explain that the northwest and southeast winds blow in a line with the coast, and are classed, the former as land winds and the latter as sea winds, not so much from their direction as their sensible qualities.

The rains were thus distributed:

Jan.	rain on	9	days,	4·52 in.	July,	rain on	0	days, 0·00
Feb.	"	9	"	4·64 "	Aug.	"	0	" 0·00
March	"	12	"	4·31 "	Sept.	"	0	" 0·00
April	"	10	"	5·59 "	Oct.	"	0	" 0·00
May	"	5	"	2·14 "	Nov.	"	7	" 1·15
June	"	0	"	0·00 "	Dec.	"	14	" 5·45

Total, rain on 66 days, 27·80 in.,—which is a larger quantity than common, as the following statement will show.

Rain in	1851	on	53 days,	15·12 in.
"	1852	on	60 "	25·60 "
"	1853	on	44 "	19·03 "
"	1854	on	54 "	22·12 "

Comparing one rainy season with another, a greater difference appears. The winter of 1850–51 furnished but 7·31 in., that of 51–52, 18·00 in., that of 52–53, 33·46 in., that of 53–54, 22·93 in., and that of 54–55, 24·10 in.

There was some hail in January, and again in December, but no snow. For a few days in each of these months the Coast Mountains in the SE were seen to be covered with snow.

The clouds were sensibly electrified five times—twice in April, once in August, once in September, and once in December. The lightning or thunder was distinct except in December when there was a regular thunder-gust with heavy thunder.

On the evenings of the 11th and 12th of August shooting stars were numerous, and still more so on the evening of December 11th. Nothing extraordinary was observed in November, about the anniversary of the great meteoric shower in 1833.

ART. XXXII.—*On the Geology of the Hudson's Bay Territories, and of portions of the Arctic and Northwestern Regions of America;** by A. K. ISBISTER, M.A., M.R.C.P. &c.

IN submitting to the society a Geological map of this extensive region, with a few explanatory remarks, my object has been to recapitulate very concisely the various observations of the geologists and travellers who have explored, and of the naturalists who have examined the organic remains of this portion of the American Continent, and to present as completely as possible the results which have been hitherto attained in the study of its geological formations. The numberless difficulties inherent in such an undertaking, embracing a range of country so vast and so difficult to explore, or even to obtain access to, must necessarily render any attempt of this nature very imperfect; but I have been

* Quart. Jour. Geol. Soc., xi, p. 497, London, 1855. [We omit the map.—EDS.]

induced to undertake it in the belief that, in the absence of any general view of the geological structure of this extensive but interesting region, even the most cursory classification of its formations might be useful to those employed in developing the structure of the crust of the earth,—the more especially as it is not probable that the attention of practical geologists will soon be directed to this distant and almost inaccessible field of investigation.

To render the present attempt as complete as the state of our knowledge will admit, I have carefully studied all the published documents and the geological collections relating to the subject to which I have been able to obtain access. And I have myself resided for many years in various parts of the territory, which I may add, I have traversed from one extremity to the other,—from the borders of the United States to the Arctic Ocean in one direction, and from the frontiers of Russian America to Hudson's Bay in the other.

The titles of the publications to which I have referred are indicated below, and may be considered as presenting a bibliographical view of what is known of the geology of this part of America.

LIST OF WORKS RELATING TO THE GEOLOGY OF THE NORTHERN PART OF NORTH AMERICA.

Northwest Coast and Russian America.

Geology of the United States Exploring Expedition under the command of Commodore Wilkes. By James D. Dana. New York, 1850.

Geological Appendix to Captain Beechey's Voyage to Behring's Straits in the ship "Blossom." By Dr. Buckland. London, 1839.

Beitrag zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nord-West Küste Amerika's. Von Dr. C. Grewingk. St. Petersburg, 1850.

Exploration and Survey of Peel's River; a portion of the chain of the Rocky Mountains and the country west of McKenzie's River. By A. K. Isbister. Journal of the Royal Geographical Society for 1846.

Hudson's Bay Territories and Arctic Regions.

Topographical and Geological Appendices to the Narratives of Sir John Franklin's First and Second Journeys to the Shores of the Polar Sea. By Dr. Richardson. And Note on the Fossils. By Prof. Jameson. London, 1825 and 1828.

Observations on the Rock Specimens collected during the First Polar Voyage of Captain Parry. By Charles König. London, 1824.

Notes on the Geology of the Countries discovered during Captain Parry's Second and Third Expeditions. By Prof Jameson. London, 1826.

Geological Appendix to the Narrative of an Attempt to reach the North Pole by Sir Edward Parry, in the year 1827. By Professor Jameson. London, 1828.

Geological Appendix to Dr. Scoresby's "Journal of a Voyage to the Northern Whale Fishery, including Researches and Discoveries on the East Coast of Grenland." By Professor Jameson. Edinburgh, 1823.

Discovery and Adventure in the Polar Seas and Regions: Edinburgh Cabinet Library; with a Chapter on Arctic Geology. By Sir John Leslie, Professor Jameson, and Hugh Murray. 1832.

Voyage of Discovery for Exploring Baffin's Bay. By J. Ross. 1819. Appendix on the Rock-specimens. By Dr. M'Culloch.

Journal of Captain Penny's Voyage to Baffin's Bay and Barrow's Straits, in search of Sir John Franklin. By Dr. P. C. Sutherland. With an Appendix on Geology. By J. W. Salter. London, 1852.

Arctic Silurian Fossils. By J. W. Salter. 1853. Quart. Journ. Geol. Soc. vol. ix.

On the Geological and Glacial Phænomena of the Coasts of Davis's Straits and Baffin's Bay. By P. C. Sutherland, M.D. 1853. Quart. Journ. Geol. Soc. vol. ix.

Rink, H., Geology of West Greenland. Trans. Roy. Soc. Denmark, 1852. (Om den geographiske Beskaffenhed af de Danske Handelsdistriker i Nordgrönland.)

Steinhauer on the Geology of Labrador. 1814. Trans. Geol. Soc. vol. ii.

Bayfield, on the Geology of the N. Coast of the St. Lawrence. 1827. Trans. Geol. Soc. 2nd Series, vol. v.

On the Geology of Lake Huron. By Dr. Bigsby. 1824. Trans. Geol. Soc. 2nd Series, vol. i.

On the Geology of the Lake of the Woods [and Rainy River]. By Dr. Bigsby. 1852. Quart. Journ. Geol. Soc. Vol. viii.

On the Geology of Rainy Lake, South Hudson's Bay. By Dr. Bigsby. 1854. Quart. Journ. Geol. Soc. vol. x.

On the Drift of the Lake of the Woods and South Hudson's Bay. By Dr. Bigsby. 1851. Quart. Journ. Geol. Soc. vol. vii.

Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River. By Captain Back, R.N. Appendix on Geology. By W. H. Fitton, M.D. London, 1836.

Journal of a Boat Voyage through Rupert's Land and the Arctic Sea, in search of the Discovery Ships under Sir. John Franklin. By Sir. John Richardson. London, 1851.

On some points of the Physical Geography of North America. By Sir. J. Richardson. 1851. Quart. Journ. Geol. Soc. vol. vii.

Report of a Geological Survey of Wisconsin, Iowa, and Minnesota, and incidentally of a portion of Nebraska Territory [including the Red River of Lake Winnipeg]. By David Dale Owen. Philadelphia, 1852.

The chief sources of information, however, on which I have relied in confirmation of my own observations are the valuable Memoirs of Mr. Salter on Arctic Silurian Fossils, published in the Quarterly Journal of the Geological Society, vol. ix, and in the Appendix to Dr. Sutherland's Journal of Capt. Penny's Voyage, and the extensive researches and the numerous able publications of the great Arctic traveller Sir John Richardson, to whom science is indebted for nearly all that is known of the natural history of the vast region surrounding Hudson's Bay.

The collections of rock-specimens and minerals brought to England by the expeditions of discovery through this territory, to which Sir John Richardson was attached, and the various Arctic expeditions by which its northern shores have been traced, as well as by those recently engaged in the search for Sir John Franklin, are very extensive, and throw much valuable light on the mineral structure of the various formations which prevail in the northern regions of America. It was not, however, until within the last few years that any considerable collection had been made of the *organic remains* belonging to these formations, by which alone their relative ages and their true characters can be determined. Some of the fossil remains alluded to have been described and figured by Mr. Salter in the papers already referred to, others by Dr. Dale Owen, of the U.S. Geological Survey, Dr. Buckland and others; and some (as will be subsequently noticed) have been described, though only incidentally and in general terms, by Sir John Richardson, Mr. Sowerby, the late Mr. König

of the British Museum, and the late Professor Jameson of Edinburgh. A considerable number remain still undescribed in the Museum of the Edinburgh University, the British Museum, the Museum of Practical Geology in Jermyn Street, and the Museum of Haslar Hospital, or are mentioned for the first time in the present paper.

An examination of these specimens leaves no doubt of the existence of a vast development of palæozoic deposits, extending with little intermission (so far as is known) from the northern frontiers of Canada and the United States to the farthest point to which our researches have extended in the Arctic Ocean, and from Hudson's Bay on the east to near the Rocky Mountains on the west,—presenting altogether a geological horizon of a grandeur and extent unequalled probably in any other part of the world, largely as the researches of Sir Roderick Murchison, Sir Charles Lyell, and others have shown such formations to be developed in Russia and the United States.

A slight sketch of the chief physical features of this wide region will demonstrate the remarkable symmetry and unbroken condition of its sedimentary deposits, and to what an unusual degree they have apparently been exempted from those igneous disturbances which have complicated the geological structure of many other countries of far less extent in other parts of the world.

TERRITORIES EAST OF THE ROCKY MOUNTAINS.

Physical Features; and Range of the Crystalline Rocks.—Separated from Canada by the great granitic range of the Laurentine or Canadian Mountains, which form the division between the hydrographic basins of these northern regions and those of the St. Lawrence and its great lakes, the Hudson's Bay Territories may be considered as forming one vast plain, diversified only by a single low granitic ridge running northwards from the west end and almost the whole north shore of Lake Superior as far as Great Bear Lake, in a direction nearly parallel with the range of the Rocky Mountains. This low belt of crystalline rocks averages about 200 miles in breadth, and is evidently the northern continuation of the Laurentine range, which after extending uninterruptedly along the northern frontiers of Canada until it comes in contact with the northern spurs of the Alleghanies near the mouth of the St. Lawrence, is deflected northwards in a direction again nearly parallel with the Rocky Mountains through Labrador and along the shores of Hudson's Straits and Baffin's Bay until it finally disappears beneath the limestones of Lancaster Sound and Barrow's Straits. The striking correspondence between the direction of this granitic range, as thus traced, and the general contour of Hudson's Bay will be at once obvious from

an inspection of the Map, and would appear to point out this vast mass of crystalline rocks as the probable axis of elevation of the great movement by which the Hudson's Bay Territories, as well as Labrador and the lands and islands along the west coast of Baffin's Bay, were first upheaved from the primeval ocean under which they once reposed. The grand chain of the Rocky Mountains may be considered also as forming a new axis of elevation, at nearly an equal distance farther west, upheaving in a similar manner the wide-spread strata which repose on its flanks.

The existence of lines of division, pursuing a parallel course, in a general meridional direction, like those just mentioned, is one of the most prominent general circumstances hitherto ascertained respecting the geology of this part of America. The course of the Rocky Mountain chain, from the Sierra of Mexico in lat. 30° to its termination on the coast of the Arctic Sea in lat. 69°, is about N by W, with very little deviation anywhere. This is also the general direction of the rugged and lofty coast range of Labrador and Baffin's Bay, as well as of the west coast of Greenland.

By carrying the eye over the map from point to point along the western edge of the crystalline belt running through the Hudson's Bay Territories, it will be seen that the average direction is the same; though, as it proceeds northwards it inclines slightly towards the Rocky Mountains, which it is to be observed however, begin here to lose their continuity; several of the western ranges being found to deviate from the general direction of the chain, and to develop themselves in irregular masses through the interior of Russian America.

We possess little reliable information respecting the structure of the mountain ranges of Labrador (on the east) or of the Rocky Mountains (on the west) north of the forty-seventh parallel, where they were crossed by Lewis and Clarke, in 1805, and no organic remains (so far as I am aware) from either locality. Sir John Richardson who is in possession of all the information respecting the Rocky Mountain range, collected from the traders of the Hudson's Bay Company and from the botanists Douglas and Drummond who crossed it between the sources of the Elk and Peace Rivers, describes the eastern slopes as consisting of conglomerate and sandstone, to which succeed limestone and clay-slates, probably of Silurian age, and granite. This view is to some extent borne out by the section of this range given by Marcou, at Fort Laramie, in lat. 42°, from the Surveys of the United State's geologists. Farther north, where the chain was explored by myself, near its termination in the Arctic Sea, the prevailing formations were found through their organic remains (as will be subsequently noticed) to be referable to certain members of the Carboniferous series, corresponding probably to the

Mountain Limestone of English geologists. From the highest part of the range, near latitude 55° N, where it attains an elevation of 16,000 feet above the sea, the four largest rivers of North America—the Missouri, the Saskatchewan, the Mackenzie, and the Columbia take their rise. It may be added, that these four feeders of opposite oceans not only take their origin from the same range of mountains, but three of them almost from the same hill,—the head-waters of the Columbia and the Mackenzie being only about "two hundred yards" apart, and those of the Columbia and the Saskatchewan, not more than "fourteen paces." It may be mentioned also as a singular fact, that one branch of the Mackenzie, the "Peace River" of Sir Alexander Mackenzie, actually rises on the western side of the Rocky Mountains within 300 yards of another large river flowing into the Pacific, the Tacoutchetesse, or Fraser's River, which discharges itself into the Gulf of Georgia, opposite Vancouver's Island.

Central Plateau of Crystalline Rocks.—Marcou, in his recently published Geological Map of the United States has traced the crystalline formation of the Laurentine Mountains a considerable distance to the westward of Lake Superior, where it appears to form the chief constituent of the low watershed which separates the waters of the Missouri from those of the Saskatchewan and other rivers flowing into Hudson's Bay.

The zone of crystalline rocks, chiefly gneiss, with granite and trap, previously alluded to as extending for a very great distance in a northwest direction from Lake Superior, is likewise very little elevated for the greater part of its extent above the surrounding country. Sir John Franklin on his first overland expedition to the shores of the Polar Sea, crossed this granitic chain nearly at right angles to its line of direction in proceeding from Hudson's Bay to Lake Winipeg, where it was 220 miles wide; it has been since crossed at various other points, and traced nearly along its entire length to the Arctic Sea. We are thus in possession of the requisite data for mapping its course and extent, and indicating its general features with considerable accuracy. Branching off from the Laurentine ranges, it assumes a northwesterly direction from the Lake of the Woods (where it first comes in contact with the limestones which underlie the prairies on the west), until it reaches Lake Winnipeg, along the eastern side of which it is then continued for about 280 miles in nearly a N NW direction. From Norway Point at the north end of Lake Winnipeg to Isle à la Crosse, a distance of 420 miles in a straight line, the western boundary has, according to Sir John Richardson, a WNW direction. For 240 miles from Isle à la Crosse to Athabasca Lake, its course turns in a somewhat irregular outline northward, enclosing the whole of that lake with the exception of its western extremity. Thence it is continued to

MacTavish Bay in Great Bear Lake, a distance of 500 miles in a general direction of about NW by W, and is marked according to Sir John Richardson, "by the Slave River, a deep inlet on the north side of Great Slave Lake, and a chain of rivers and lakes, including Great Marten Lake, which discharge themselves into that inlet." From Great Bear Lake to the sea it follows the general course of the Coppermine River, its termination being marked by the mouth of that stream in lat. 71° 55′ N and long. 120° 30′ W; or perhaps more correctly by Richardson's River, a little to the west of it. In this part for the first time the chain rises to the altitude of hills, marked on the Map as the Copper Mountains, which attain in some parts a height of 800 feet above the bed of the river. The slight elevations composing the main portion of the chain seldom rise, as has been already observed, much above the level of the surrounding country, giving to the entire range the character of a low swampy plateau of crystalline rocks, covered by an immense network of small lakes and swamps, connected by narrow and tortuous channels. The low rugged knolls of granite and gneiss, round which these channels wind, "have mostly," says Sir John Richardson, "rounded summits, and they do not form continuous ridges, but are detached from each other by valleys of various breadth, though generally narrow and very seldom level. When the valleys are of considerable extent, they are almost invariably occupied by a lake, the proportion of water in this district being very great; from the top of the highest hill on the Hill River thirty-six lakes are said to be visible. The small elevation of the chain may be inferred from an examination of the Map, which shows that it is crossed by several rivers that rise in the Rocky Mountains, the most considerable of which are the Churchill, and the Saskatchewan or Nelson Rivers. These great streams have, for many hundred miles from their origin, the ordinary appearance of rivers in being bounded by continuous parallel banks, but on entering the primitive district, they present chains of lake-like dilatations, which are full of islands and have a very irregular outline. Many of the numerous arms of these expansions wind for miles through the neighboring country, and the whole district bears a striking resemblance, in the manner in which it is intersected by water, to the coast of Norway and the adjoining part of Sweden. The successive dilatations of the rivers have scarcely any current, but are connected with each other by one or more straits, in which the water-course is more or less obstructed by rocks, and the stream is very turbulent and rapid. The most prevalent rock in the chain is gneiss; but there are also granite and mica-slate, together with numerous beds of amphibolic rocks."

The entire length of this remarkable plateau, from Lake Superior to its termination on the Arctic Sea, may be estimated at

somewhat more than 1500 miles. Such an enormous extension of crystalline and eruptive rocks, nowhere assuming the character of a mountain district, is a remarkable example of the tranquil operation of an upheaving force exerted over an immense area, yet with a limited and regulated intensity, and a constancy of direction which render it worthy of attention, not only as a striking geological phenomenon, but as serving, perhaps, to throw some light on the dynamical conditions under which those vast sedimentary deposits which have excited the astonishment of geologists in America from their unparalleled extension have been originally upheaved.

It may be mentioned also as another remarkable circumstance in connexion with this granitic tract, that it is along its western margin, in the line of its junction with the limestones and other secondary deposits which extend between it and the Rocky Mountains, that all the great lakes of America are found. If we regard Lake Erie and Lake Michigan as expansions respectively of Lake Ontario and Lake Huron (being evidently component parts of the same lake-basins), we shall find the following series of great lakes—Lake Ontario, Lake Huron, Lake Superior, Lake Winipeg, Athabasca Lake, Great Slave Lake, Marten Lake, and Great Bear Lake, succeeding one another in a NNW direction along the line of fracture, and invariably bounded to a greater or less extent on one side (generally the northern or eastern) by crystalline rocks, and on the opposite side by limestones and other secondary formations; the northern coast-line being moreover indented nearly in the same general bearing by Coronation Gulf, where, as already stated, the line of crystalline rocks terminates. It is to be observed, however, that the rivers connecting these lakes run generally wholly in one formation or in the other.

Silurian Basin of Hudson's Bay.—The granitic tract just described is bounded to the eastward by a narrow belt of limestone, beyond which there is a flat swampy and partly alluvial district, forming the shores of Hudson's Bay. The west coast of the bay is everywhere extremely low, and the depth of water decreases so gradually on approaching it, that in seven fathoms of water the tops of the trees on the land are just visible from a ship's deck. Large boulder-stones are scattered over the beach, and sometimes form shoals as far as five miles from shore. A low and uniformly swampy aspect characterizes the surrounding country for several miles inland. The upper soil presents a thin stratum of half-decayed mosses, immediately under which we find a thick bed of tenacious and somewhat shaley bluish clay containing boulder-stones. Beyond this occurs an extensive deposit of limestone, completely encircling Hudson's Bay, and following the course of the crystalline rocks to the extreme limit of our researches in the Arctic Sea.

Dr. Conybeare, in his Report on Geology, to the British Association for 1832, had noticed the great similarity between the fossils brought to England by the Arctic Expeditions of Parry and Franklin, and those of the Silurian formations of our own country. The Geological Notices appended to the Narratives of those Expeditions by Professor Jameson, Mr. König, and Sir John Richardson, who had the advantage of Mr. Sowerby's assistance in examining the organic remains, had previously led to the same view; and it may now be considered as finally established by Mr. Salter's examination and description of the extensive collections from the Arctic Regions,* brought to England by the recent expeditions in search of Sir John Franklin. The formation described by Dr. Sutherland as extending along the shores of Wellington Channel and Barrow's Straits, and considered by Mr. Salter to belong to the Upper Silurian group, has since been identified, through its organic remains, at several points along the coasts of Hudson's Bay. Recognized by Mr. Logan at Lake Temiscamang, and at Lakes Abbitibie and St. John, on the northern edge of the Laurentine Mountains, it has been successively identified along the Moose and Albany Rivers flowing into James's Bay, at Marten's Falls,† and along the northern edge of the granitic plateau, thence to York Factory, along the Great Fish River of Sir George Back,‡ at Igloolik,§ and along both shores of Prince Regent's Inlet,‖ to which last-mentioned locality Mr. Salter's investigations bring us down. The extreme points here indicated are Lake Temiscamang, in 47° 19′ N, and the shores of Wellington Channel, between 77° and 78° N, giving the enormous range of 30 degrees of latitude, over which, as far as our present information reaches, the Silurian formation extends uninterruptedly without any important variation, so far as is known, either in its mineralogical constitution or its stratification. The fossils from this district hitherto submitted to Mr. Salter's examination belong exclusively to the Upper Silurian. They are comprised in the following list; and most of them are figured in the Appendix to Dr. Sutherland's Journal of Captain Penny's Expedition.

* Quart. Journ. Geol. Soc. vol. ix, p. 313.

† By Sir John Richardson and Mr. Barnston. "Boat Voyage through Rupert's Land," vol. ii.

‡ Dr. Fitton and Mr. Stokes. § Professor Jameson.

‖ Sir Roderick Murchison, 'Siluria,' p. 428. I cannot omit, in this sketch of the geology of so large a portion of the North American Continent, to refer to the very accurate discrimination and description of its leading features contained in the recently published work of Sir Roderick Murchison on 'Siluria.' To this important work, and to the long series of researches of which it is the fruit, the geologists of America must feel under the highest obligation, not only for the clear and comprehensive view it exhibits of the whole phenomena of Palæozoic rocks throughout that continent, but for the important and valuable aid it affords to the explorer and investigator of its organic remains, by the establishment of a definite and perspicuous standard of comparison and reference, by which its geological formations can be identified and described.

Crustacea.

1. Encrinurus lævis, *Angelin*?
2. Proetus, sp.
3. Leperditia Balthica, *Hisinger* sp., var. *arctica*, Jones.

Mollusca.

4. Lituites, sp.
5. Orthoceras Ommaneyi, *Salter*.
6, 7. ——, 2 species.
8, 9. Murchisonia, 2 sp.
10. Euomphalus, sp.
11. Bellerophon nautarum, *Salter*.
12. Modiola (or Modiolopsis).
13. Strophomena Donnetti, *Salter*.
14. ——, sp.
15. Orthis.
16. Spirifer crispus, *Linn.* sp.?
17. ——, sp.
18. Chonetes lata, *Von Buch*?
19. Pentamerus conchidium, *Dalm.*
20. Rhynchonella Phœa, *Salter*.
21. —— Mansonii, *Salter*.
22. —— sublepida, *De Vern.*
23, 24. ——, 2 sp.
25. Atrypa reticularis, *Linn.* sp.

Encrinites.

26. Actinocrinus, sp.
27. Crotalocrinus, sp.

Corals.

28. Ptychophyllum.
29. Strephodes Pickthornii, *Salter*.
30. —— ? Austini, *Salter*.
31. Favistella reticulata, *Salter*.
32. —— Franklini, *Salter*.
33. Fenestella, sp.
34. Favosites polymorpha, *Goldfuss*.
35. —— Gothlandica, *Linn.* sp.
36, 37. ——, 2 sp.
38. Columnaria Sutherlandi, *Salter*.
39. Halysites catenulatus, *Linn.* sp.
40. Syringopora, sp.
41. Heliolites (Porites).
42. Cystiphyllum, sp.
43. Cyathophyllum, sp.
44. Clisiophyllum, sp.
45. Aulopora, sp.
46. Cœnites (Limaria), sp.
47. Calophyllum phragmoceras, *Salter*.
48. Arachnophyllum Richardsonii, *Salter*.

Mr. König describes the limestones from which these remains have been obtained as of an ash-grey or yellowish and grey color, often fœtid, and sometimes crystalline or compact, strongly resembling the Transition limestones of Gothland, and some of the fœtid varieties of the Mountain Limestone of Derbyshire. He mentions also that it is filled with zoophytes and shells; and in some parts is quite made up of the detritus of Encrinites, the fragments of which are so comminuted that the rock might readily be mistaken for a granular limestone.

A small collection of fossils* recently procured by the writer from James's Bay (the southern extremity of Hudson's Bay), which have been submitted to Mr. Salter, but not yet named, exhibit the same general Upper Silurian character with those above quoted. They comprise specimens of the same Corals (*Favosites Cyathophyllum*, *Clisiophyllum*, and *Favistella*), the universal *Atrypa reticularis*, *Pentamerus oblongus*, several Spirifers and *Orthidæ*, *Orthoceras*. Mr. Barnston, of the Hudson's Bay Company's Service, who has resided for upwards of twenty years in various parts of the district under notice, and whose qualifications as an observer are highly spoken of by Sir John Richardson, has traced the Silurian rocks from James's Bay to Marten's Falls, near the source of Albany River, at the eastern

* The fossils were collected by Dr. Roderick Kennedy, the Medical Officer at Moose Factory.

edge of the granitic plateau, which would give an average breadth of about 200 miles for the formation in this part. The boat-route from Lake Winnipeg to York Factory crosses the limestone belt at right angles to its course at Rock Portage, and its breadth is there found to diminish to less than 100 miles. The average width of the formation may perhaps be estimated at about 150 miles.

The mineral structure of the rocks forming the northern shores of America has been so fully and minutely investigated and described by Prof. Jameson, Mr König, Dr. Fitton, and Sir John Richardson, that I shall here, as well as in the notices of the other formations of this territory, confine myself exclusively to the examination of their organic remains, referring the reader for every necessary information on the mineralogical character of the rocks in which they are found to the valuable publications of those authors.

Silurian Basin of Lake Winipeg.—To the westward of the plateau of crystalline rocks, and following its course for a considerable distance northward, lies an extensive deposit of horizontal limestone, underlying the wide prairie country which extends towards the Rocky Mountains. Lake Winipeg, which is situated on the line of junction of the two formations, is a long and narrow sheet of water, 230 geographical miles long, and about 40 wide; and with its associated lakes (Moose Lake, Muddy Lake, Winepegoos, and Manitoba Lakes), receives, through its affluents—the Saskatchewan, the Red River, and other streams—a wide extent of prairie drainage. The commercial route from Lake Superior up to this point lies almost wholly within the granitic tract, touching on Silurian deposits only at the mouth of Rainy River and at one of the southwestern arms of the Lake of the Woods, where Dr. Bigsby has detected a few organic remains indicative of the Upper Silurian formation.* The Winipeg flows wholly within the granitic district, and has the lake-like dilatations and other characteristics of the streams which traverse the crystalline tract. When we descend to Lake Winipeg, we come upon epidotic slates, conglomerates, sandstones, and trap-rocks, which bear a close resemblance to those of the mining district of Pigeon Bay on Lake Superior. After passing the straits of Lake Winipeg, we have granitic rocks on the east shore and Silurian rocks on the west and north, the basin of the lake being mostly excavated in the limestone. The granite and gneiss which form the east shore of Lake Winipeg strike off at its NE corner, and passing to the north of Moose Lake, go on to

* The following list is given by Dr. Bigsby: a small *Phacops*, small *Orthocerata*, minute Encrinital columns, *Favosites Gothlandica*, *Cyathophyllum*, *Murchisonia*, *Pentamerus Knightii*, *Leptæna*, *Avicula*, *Atrypa*, and *Spirifer*. Quart. Journ. Geol. Soc. vol viii, p. 405.

Beaver Lake, where the boat-route again touches upon them. The extension of the limestone in a westerly direction from Lake Winipeg has not been ascertained; but it has been traced as far up the Saskatchewan as Carlton House, where it is at least 280 miles in breadth. Beyond this it is either succeeded or covered by cliffs of calcareous clay, which bear some resemblance to those found along the banks of the upper portions of the Missouri, together with saliferous marls and beds of gypsum.

Skirting the base of the Rocky Mountains a remarkable lignite formation is met with, which is said to extend through the valley of the Mississippi and of Mackenzie River as far north as the Arctic Sea.

The limestone of Lake Winipeg, which undoubtedly covers a vast tract of country, may in general be characterized as compact and splintery, and of a yellowish-white color, passing into buff, and sometimes of an ash-grey, mottled, or banded with patches of light brown. In the district between Lake Winipeg and the Saskatchewan, more particularly examined by the Arctic Expeditions of Franklin and Back which passed through it on their way to the Arctic Sea, the limestone strata were found to be almost everywhere extensively exposed, and to be remarkably free from intrusive rocks. Professor Jameson enumerates *Terebratulæ*, *Orthocerata*, *Encrinites*, *Caryophyllidæ*, and *Lingulæ*, as the organic remains brought to England by Franklin's First Expedition; Mr. Stokes and Mr. Sowerby examined those fossils which were procured on the Second Expedition, and found amongst them *Terebratulites*, Spirifers, Corallines, and *Maclurites*. The *Maclurites* were probably the *Maclurea magna* of Le Sueur and Hall. Sir John Richardson has recently brought home from the same quarter a fine specimen of the *Receptaculites Neptunii*,—a fossil, which, though it occurs abundantly in some of the Devonian beds of the Eifel, is, with the Maclurite, characteristic in Canada, as in New York, of the Lower Silurian.

Along the southern shores of Lake Winipeg and in the Valley of the Red River, where the limestone rises in solid ledges from the surrounding prairies, and has been extensively quarried for building purposes, it has been distinctly identified as belonging to that formation by Dr. Dale Owen, Director of the Geological Survey of Wisconsin and Minnesota, who in the course of his explorations visited the small colony settled there by the Hudson's Bay Company. In his recently published Report, Dr. Dale enumerates the following fosssils procured by him from the quarries at Red River and from Lake Winipeg:—

1. Favosites basaltica.
2. Coscinopora sulcata.
3. Chætetes lycoperdon.
4. Pleurorhynchus, sp.
5. Ormoceras Brongniarti.
6. Leptæna sericea?†
7. —— alternata.
8. —— planoconvexa?
9. Calymene senaria.
10. Pleurotomaria lenticularis?

11. —— muralis.†
12. Orthis, sp.†
13. Lingula, sp.†
14. Terebratula, sp.†
15. Cytherina ?†
16. Syringopora.
17. Pleurorhynchus ?
18. Cephalic shield of a Trilobite allied to *Illænus arcturus.*†
19. Pustulated cephalic shield of an Illænus.†
20. Conularia, sp.
21. Several specimens of the shield of Illænus crassicauda.

Note.—Those marked † are figured in Dr. Owen's Atlas of Illustration.

Many of these, Dr. Owen states, "are identically the same fossils as occur in the lower part of 'Formation No. 3,' in Wisconsin and Iowa, in the blue limestones of Indiana, Ohio, Kentucky, and also in the Lower Silurian of Europe. The *Coscinopora* is precisely the same as the coral which is particularly characteristic of the lower beds of the Upper Magnesian Limestone of Wisconsin. The specimens of *Favosites basaltica* cannot be distinguished from those which abound in the Upper Magnesian Limestone of Wisconsin and Iowa and the Lower Coralline beds of the Falls of the Ohio."

It has been noticed that the limestones of this formation are distinguished by two different tints of color. From the following analyses of the two varieties published by Dr. Owen, it would appear that they differ also considerably in their mineralogical character.

Analysis of the Compact Limestone from Red River, containing *Leptæna.*		Spotted and banded Limestone containing *Coscinopora.*	
Carbonate of Lime	53·7	Carbonate of Lime	78·1
Carbonate of Magnesia	40·5	Carbonate of Magnesia	17·8
Insoluble matter	0·8	Insoluble matter	1·0
Alumina, Oxyd of Iron, and Manganese	4·0	Alumina, Oxyd of Iron and Manganese	1·4
Water and loss	1·0	Water and loss	1·7
	100·0		100·0

It has been stated that none of the fossils from the Hudson's Bay Basin hitherto submitted to Mr. Salter belong to the lower division of the Silurian. It is proper to observe, however, that Mr. Salter has expressed some doubt of the age of the limestone of Igloolik, Melville Peninsula, and Amherst Island, amongst the organic remains of which Professor Jameson and Mr. Stokes detected some Trilobites, a Maclurite, and a Coral, which last fossil from the description given of it may have been a *Receptaculites;* and it may be added, that Marcou, apparently on the authority of Mr. Logan, classes the limestones of Lakes Abbitibie and St. John as Lower Silurian. The limestones of the Kakabeka Falls were identified by himself as belonging to that division. The insufficiency of geological explorations, and the want of published documents, render it impossible as yet to define with any approach to accuracy the limits of the two great divisions of the formation in this part of America, while it may be safely asserted, however, that under one or other of its forms the Silu-

rian formation attains probably a wider development in the Hudson's Bay Territories than in any other part of the world in which its existence has been hitherto ascertained. Sir John Richardson has detected it in the hollows of the granitic plateau, and he expresses a belief that it will be found to occupy all the valleys of that extensive district.

Devonian Formation of the Elk or Mackenzie River.—The extent of the Silurian formation of Lake Winipeg northward has not been accurately ascertained. Limestones very similar in character have been traced on Beaver River, the most westerly feeder of Churchill River, and situated midway between the Saskatchewan and Elk Rivers. The canoe-route does not touch upon this river, which has its outlets in one of the southwestern arms of Lake La Crosse; but it is observed that the country on entering Sandy Lake along the line of communication near this part suddenly changes its aspect. Banks of loam, sand, and rolled blocks of a fine quartzose sandstone are found along the channels of the rivers; and shortly after emerging from the granitic district through which the route lies for the greater part of the distance from Cumberland House to Fort Isle-à-la-Crosse, we come upon a formation of quite another character, occupying the basins of the Elk River and its affluent the Clear-water.

The Elk River, the most southerly feeder of the Mackenzie, originates in the Rocky Mountains, as already stated, near the northern sources of the Saskatchewan; and its bed, which forms with that stream two sides of an equilateral triangle, with its base resting on the western edge of the crystalline plateau, is not separated by any marked ridge from the Saskatchewan prairie country, which appears to extend with little interruption as far as the next great tributary of the Mackenzie, the Unjigah or Peace River. It is separated from the Churchill or Mississippi River system, having its outlet in Hudson's Bay, by the carrying place of Portage La Loche, a plateau of about ten miles in breadth, which forms the dividing ridge between the waters flowing into Hudson's Bay and those flowing into the Arctic Sea. Portage La Loche has at its highest point an elevation of about 60 feet above the sources of the Churchill River system; but it presents on the side of the Clear-water River a sudden and precipitous descent of 656 feet, disclosing a deep layer of sand, enclosing masses of sandstone, of about 600 feet in depth; the whole reposing upon an extensive formation of limestone which lines the whole bed of the Clear-water as far as its junction with the Elk River. The deposits of sand and sandstone alternate with thick beds of bituminous shale, in some parts more than 150 feet in depth. These bituminous deposits form the distinguishing features of the formation now under notice, and are developed to an enormous extent, having been traced at intervals along the whole

length of Mackenzie River as far as the shores of the Arctic Sea. Springs and pits of fluid bitumen are of common occurrence, and along the banks of Elk River in particular the shale beds are so saturated with this mineral as to be nearly plastic. The whole formation bears a decided resemblance in its lithological character to the lower members of the "Erie Division" of the United States' geologists, which M. de Verneuil considers to be equivalent to the Devonian formation of Europe*. I have been enabled, through the kindness of Mr. S. P. Woodward, to examine the collection of fossils from this district in the British Museum; and although, from the poverty of organic remains (a circumstance characteristic of the formation also in the United States), the collection is a very small one, there can be no hesitation in assigning the bituminous deposits of the Elk and Mackenzie Rivers to the epoch of the Marcellus shales, and the associated limestones, of the New York Survey.

The most characteristic fossil of the bituminous beds is a small Pteropodous shell, thickly disseminated through the substance of the shale, apparently the *Tentaculites fissurella* of Hall, associated with *Strophomena mucronata*, *S. setigera*, and *Orthis limitaris*, of the same author; at least they cannot be distinguished from his figures of those fossils from the Marcellus shales.

Two corals from the associated bituminous limestone are, according to Mr. Woodward, characteristic of the same epoch, namely a *Strombodes* (of Hall), having its cysts filled with bitumen, and a *Favosites*, very like the common *F. polymorpha* of the Plymouth marbles. From the underlying limestones of the Elk River, Sir John Richardson collected several specimens of *Productus* (among them *P. subaculeatus*), an *Orthis* resembling *O. resupinata*, *Terebratula reticularis*, a *Posidonomya*, and a *Pleurotomaria*. There is a very fine and well preserved *Rhynchonella* amongst the collection, remarkable for retaining the original chesnut-colored bands of the shell.

Other Formations of the Mackenzie River Basin.—Silurian rocks of Great Slave Lake and River (Onondaga Salt Group of Vanuxem and Hall?).—After passing through Lake Athabasca the Elk River is joined by the Unjigah or Peace River, the largest tributary of the Mackenzie, and the united streams, under the name of Slave River, proceed onwards to Slave Lake along the edge of the district of crystalline rocks, flowing sometimes through limestone, at other times over granite, and sometimes between the two. The mouths of Slave River open into Slave Lake between the limestone and granite. The limestones along the banks of this stream are, like those of the Elk River, highly bituminous; but they are chiefly remarkable from their association with extensive beds of compact greyish gypsum, in connex-

* Bulletin Soc. Géol. Fr. 2 Sér. vol. iv, p. 646.

ion with extremely copious and rich salt-springs. Where they approach the crystalline rocks, they are found, like those of Lake Winipeg to be highly magnesian,—a circumstance which may deserve attention with reference to the hypothesis of *dolomization*, which regards the introduction or development of magnesia as subsequent to the deposition of the calcareous matter, and as connected with the proximity of masses containing that earth and heated to a very high temperature. Among the fossils collected from this district which are in the British Museum are *Spirifer crispus*, Dalm. ?, *Rhynchonella phoca*, Salter, *Atrypa lævis*, Vanuxem, *Atrypa reticularis*, an *Orthis*, two small *Spirifers*, like *S. trapezoidalis*, Dalm. and *S. pisum*, Sow., and fragments of an Encrinital stem like that of *Actinocrinus*. Sir George Back, on his expedition down the Great Fish River, collected some fragments of Corals along the south shore of Slave Lake, which were considered by Mr. Stokes and by Mr. Lonsdale to belong some to *Catenipora escharoides*, and one to the genus *Stromatopora* of Goldfuss, and probably to his species *S. polymorpha*. From the circumstance of these fossils being chiefly Upper Silurian, it has been conjectured with every appearance of probability, that the salt-springs may belong to the "Onondaga Salt Group" of [below] the "Helderberg division" of the New York system.

Carboniferous Series (*Mountain Limestone?*).—Some of the organic remains procured by Sir John Richardson on a previous expedition from other points along the Mackenzie River would appear to indicate an ascending order in some of the deposits of that district from the Devonian limestones and the shales containing *Tentaculites* into beds of Carboniferous, or perhaps more recent age. In some specimens from the limestone* of the "Ramparts" in the lower part of Mackenzie River, brought to England in 1826, Mr. Sowerby discovered *Terebratula sphæroidalis*, together with a species common in the carboniferous limestone of Nehou in Normandy, some *Producti*, and a Coral of the genus *Amplexus*. From other parts along the banks of the same river several *Terebratulæ* were procured, one resembling *T. resupinata*, one *Spirifer acutus*, a *Cirrus*, some Crinoidal remains, and Corals,—a somewhat perplexing assemblage if they were all collected from the same spot. Most probably some of the specimens have been derived from the boulders and transported fragments with which this part of the country is covered.

* The limestone of the "Ramparts," which appears again lower down at a spot called the "Narrows," is continued in a westerly direction to the Rocky Mountains, the lower elevations of which are composed of it in that portion of the range through which Peel's River takes its course. It has all the characters of the Mountain Limestone of English Geologists,—a formation extensively developed in Russian America, where, as will be subsequently noticed, it has been clearly identified by its organic remains.

Lignite Formation.—The difficulty of deciding upon the age of the beds through which the lower part of Mackenzie River flows, is increased by the occurence among them of a Lignite-formation, covered in parts by deep beds of sand, capped by boulders and gravel. The soft friable shales forming the bank of the river near its termination in the Arctic Sea are also strongly impregnated with alum. These aluminous shales cover a large portion of the delta of Mackenzie River, are continued along the banks of Peel's River to the foot of the Rocky Mountains, and have been traced for a considerable distance along the coast, and also along the shores of Great Bear Lake. The aluminous shale is constantly associated with the bituminous formation, into which it often passes.

The lignite-formation is still more extensively developed; and, as the occurrence of coal in any form in these high latitudes is a question of much interest, I shall here state briefly the results of Sir John Richardson's observations and enquiries on the subject, to which he has given much attention.

The Mackenzie traverses very obliquely the basin in which the lignite-formation is deposited, while Bear Lake River cuts it more directly across; and it is at the junction of these two streams that the formation is best exposed. It there consists of a series of beds, the thickest of which exceeds three yards separated by layers of gravel and sand, alternating with a fine-grained friable sandstone, and sometimes with thick beds of clay, the interposing layers being often dark, from the dissemination of bituminous matter. "The coal, when recently extracted from the bed," says Sir John Richardson, "is massive, and most generally shows the woody structure distinctly; the beds appearing to be composed of pretty large trunks of trees, lying horizontally, and having their woody fibres and layers much twisted and contorted, similar to the White Spruce now growing in exposed situations in the same latitude. Specimens of this coal examined by Mr. Bowerbank were pronounced by him to be decidedly of coniferous origin, and the structure of the wood to be more like that of *Pinus* than *Araucaria*; but on this latter point he was not certain. It is probable that the examination of a greater variety of specimens would detect several kinds of wood in the coal, as a bed of fossil leaves, connected with the formation, reveals the existence at the time of various dicotyledonous trees, probably *Acerineæ*, and one of which appears to belong to the Yew tribe." . . . . . "Different beds, and even different parts of the same bed, when traced to the distance of a few hundred yards, present examples of 'fibrous brown coal,' 'earth-coal,' 'conchoidal brown coal,' and 'trapezoidal brown coal.' Some beds have the external characters of a compact bitumen; but they generally exhibit on the cross fracture concentric layers, although from their jet-like composition

the nature of the woody fibres cannot be detected by the microscope. Some pieces have a strong resemblance to charcoal, in structure, color, and lustre. Very frequently the coal may be named a 'bituminous slate,' of which it has many of the lithological characters; but, on examination with a lens, it is seen to be composed of comminuted woody matter mixed with clay and small imbedded fragments resembling charred wood. From the readiness with which the coal takes fire spontaneously, the beds are destroyed as they become exposed to the atmosphere, and the bank is constantly crumbling down; so that it is only when the debris has been washed away by the river that good sections are exposed."*

Formations similar to that found on Mackenzie River extend southward along the eastern base of the Rocky Mountains, as far as the Saskatchewan River. Sir John Richardson gives a detailed account of the various localities between these two points in which beds of coal have been exposed,—all pointing to the existence of a vast coal-field, skirting the base of the Rocky Mountains for a very great extent, and continued probably far into the Arctic Sea, where, as is well known, lignite, apparently of a similar character, has recently been discovered by Captain McClure in the same general line with the localities above mentioned.† In the coal of Jameson Land, lying in north latitude

* With reference to the southern portion of this coal-field, where it is exposed in the valley of the Saskatchewan, Sir George Simpson, Governor of the Hudson's Bay Territories, has the following remarks, in his 'Narrative of an Overland Journey round the World,' vol. i, p. 162:—

"Near Fort Edmonton a seam of coal, about 10 feet in depth, can be traced for a very considerable distance along both sides of the river. This coal resembles slate in appearance; and, though it requires a stronger draught of air than that of an ordinary chimney, yet it is found to answer tolerably well for the blacksmith's forge. Petrifications are also found here in abundance, and at the Fort there was a pure stone which had once been a log of wood about 6 feet in length and 4 or 5 in girth, the resemblance being so complete as even to deceive the eye."

Sir Alexander McKenzie traced the same formation along the upper parts of the Peace River; and it has been found by the traders of the Hudson's Bay Company at several intermediate points along the same general line; leading to the conclusion that the formation in question is continuous and uninterrupted.

† Similar deposits to those discovered by Capt. McClure have been found in the New Siberian Islands, and are thus described in Wrangell's Polar Voyages:—"Of these [speaking of the deposits of fossil wood in the New Siberian Islands] Hedenström observes in another place, 'On the southern coast of New Siberia are found the remarkable Wood Hills. They are 30 fathoms high, and consist of horizontal strata of sandstone alternating with strata of bituminous beams or trunks of trees. On ascending these hills, fossilized charcoal is everywhere met with, covered apparently with ashes; but on closer examination, this ash is also found to be a petrifaction, and so hard that it can scarcely be scraped off with a knife. On the summit another curiosity is found, viz. a long row of beams, resembling the former, but fixed perpendicularly in the sandstone. The ends, which project from 7 to 10 inches, are for the greater part broken. The whole has the appearance of a ruinous dyke.' Lieut. Anjou, who likewise examined these Wood Hills, says, 'They are merely a steep declivity, 20 fathoms high, extending about five wersts along the coast. In this bank, which is exposed to the sea, beams or trunks of trees are found, generally in an horizontal position, but with great irregularity, fifty or more of them together,

71° (on the east side of Greenland), and in that of Melville Island, in latitude 75° north, Professor Jameson found plants resembling those of the coal-measures of Britain; and similar remains have been reported from the coal-fields of Oregon and Vancouver's Island. These facts are sufficient of themselves, as is remarked by Sir John Richardson, to raise a world of conjecture respecting the condition of the earth when these ancient fossils were living plants. If the great coal-measures, containing similar vegetable forms, were deposited at the same epoch in distant localities, there must have existed when that deposition took place a similarity of condition of the North American Continent from latitude 75° down to 45.°*

Elevatory Movements; and Pleistocene deposits.—Into such questions, however, as the above, or into the discussion of the various hypotheses by which the elevations and depressions of the surface of these vast territories may be accounted for, it is beyond the province of the present paper to enter; nor, in the present state of our knowledge, would a summary of this kind admit of the necessary elucidation. I shall merely say, that, adopting the opinion of Sir John Richardson and the geologists of the United States, that "the eastern portion of the continent was first elevated, and that the older rocks on the west were subsequently overlaid by newer deposits," I consider that the great mass of the underlying formations surrounding Hudson's Bay are wholly palæozoic, and that the currents or waves of translation, if such there were, must have had an easterly direction in these latitudes, and gained strength as they rolled towards the Atlantic, when they swept away wholly or partially the fossiliferous deposits that covered the older rocks of Hudson's Bay, Canada, and the eastern parts of the United States; the former extent of the newer rocks being indicated by the patches which remain. The only recent formations overlying the Silurian rocks which have been hitherto discovered along the eastern coasts of Arctic America, are patches of pleistocene deposits, with marine shells of existing Arctic species (*Mya truncata*,

—the largest being about 10 inches in diameter. The wood is not very hard, is friable, has a black color and a slight gloss. When laid on the fire, it does not burn with a flame, but glimmers, and emits a resinous odor.'"—Narrative of an Expedition to the Polar Sea, by Admiral F. von Wrangell, of the Russian Imperial Navy, in 1820–23. (Edited by E. Sabine) Introd. p. cxviii.)

The "charcoal" and "ashes" are no doubt the result of the spontaneous combustion of the lignite, as is the case with the lignite deposits at Bear Lake and other parts of the Hudson's Bay Territories, where they take fire on being exposed to the air, and have been observed burning for the last hundred years. The Wood Hills in the New Siberian Islands are in the same general line with the lignite extending along the Rocky Mountains, and with the wood deposite discovered by Capt. Mc Clure.

* The coal bed of the Cowlitz, Oregon, is Tertiary, and the plants from Puget's Sound collected by Mr. Dana were also Tertiary. See also a note by Mr. Gibbs, in this Journal, [2], xx, 298.—Eds.

Saxicava rugosa, &c.); the whole crowned by an immense profusion of boulders and erratic blocks. The country forming the Hudson's Bay Territories is too flat for the immense erratic formation extending over every part of it to be explained by reference to the motion of glaciers; and I think it is more probably due to the action of icebergs and floating masses of ice, still so common along these coasts, and which are without doubt performing at the present day precisely a similar office, in strewing the bed of the ocean in which they are found with the fragments transported from the adjacent shores.*

With reference to the character of the pleistocene or drift formation, it may be mentioned that as we ascend the rivers of this region, especially along the basins of Lake Winipeg and its affluents in the prairie districts, the sandy and clayey deposits are found to abound with land and freshwater shells, such as *Unio*, *Helix*, *Pupa*, &c., of species now living on the borders, or in the beds of the rivers and lakes. The cliffs containing these shells are often raised more than 100 feet above the present levels of the banks of the streams, and appear to be ancient lake- or river-terraces; leading to a belief that, great as is the present extent of freshwater surface in the North American Continent, it was at one time still greater, and that the existing series of lakes, from the St. Lawrence northward, were perhaps anciently united in one or more vast freshwater seas, having their western margins indicated, perhaps, by the peculiar elongated strip occupied by the lignite-formation previously described, which presents precisely the appearance which would result from a long line of shelving beach, piled with masses of drift-wood accumulated through long successive periods, similar to what is now found covering the shores of the inland lakes and portions of the coasts of the Arctic Seas.

It has been stated as an exemplification of the wide changes which would result from a comparatively small alteration in the present level, even of such mountainous districts as Canada and the Northeastern States of the Union, that "a subsidence of 400 feet would cause the waters of Lake Ontario, to flow through the valleys of the Mohawk and Hudson into the Atlantic, and at the same time convert Lake Champlain into a maritime strait, thereby forming islands of the States of New York, New England, and Maine, and of the British Colonies of New Brunswick and Nova Scotia." A subsidence of one-fourth of that amount in the prairie districts of the Saskatchewan, continued to Great

* In the Appendix to Dr. Scoresby's 'Journal of a Voyage to the Northern Whale Fishery,' Professor Jameson enumerates among the specimens found on an iceberg near Cape Brewster the following:—

1. Transition clay slate.
2. Slaty talcose granite.
3. Granular felspar.
4. Hornblende mica-slate.
5. Gneiss.
6. Basaltic greenstone.

Bear Lake, would carry the waters of the Missouri and the upper portions of Churchill, and Mackenzie Rivers into Lake Winipeg and convert the plain country bordering on the Rocky Mountains, into an inland sea. Even at the present level the Missouri has twice within the last thirty years, inundated the valley of the Red River, flowing into Lake Winipeg; while it is a common occurrence for the country through which the lower part of the Saskatchewan flows to be laid under water for a distance of 200 miles above its outlet by an ordinary spring-flood. About forty years ago, in a season remembered especially for the land-floods, a gentleman in the service of the Hudson's Bay Company was drowned on the Frog Portage (the low watershed which separates the Saskatchewan and Churchill Rivers), by his canoe upsetting against a tree in passing from one stream to the other.

The raised beaches of Lake Superior, rising in four or five successive terraces to the height of more than 100 feet above the present surface of the water, and which have attracted the attention of Professor Agassiz and the geologists of the Canadian Survey, appear to point to the existence at some former period of a much greater body of water in this lake, at least, than is at present contained in it, and are to some extent therefore confirmatory of the view now suggested.

The Eocene basin of the Upper Missouri, with its very marked character of freshwater deposition, is stated by Marcou to extend along the upper waters of the Saskatchewan as far as Mackenzie River. I have no knowledge of any such formation myself, although in the unexplored territory west of the Winipeg basin there is undoubtedly ample room for its development. Its existence, if established, would lend additional probability to the inference deducible from the circumstances previously noticed.*

Territories West of the Rocky Mountains.—Physical Features.—"The great contrast between the east and west sides of the Rocky Mountains has been often mentioned,—the one abounding in sandstone with argillaceous limestones, *without* volcanos or volcanic rocks, while on the other side recent igneous rocks prevail (basalts, basaltic lavas, and trachytes),† and the

* The views here suggested are not to be considered as prejudging the question so ingeniously developed by Mr. W. Hopkins and supported by the late Prof. E. Forbes respecting the probability of the passage of the Gulf Stream at some former period up the valley of the Mississippi (Quart. Journ. Geol. Soc. vol. viii, p. 89, &c.),—a theory of the highest interest and importance in accounting for the changes of temperature and climate on the surface of our globe, and which, though based by its author upon purely physical considerations, is in harmony with all the geological facts and evidence which have come under the writer's notice.

The age of freshwater accumulations and deposits suggested in the text comes much nearer to our own times.

† Dr. Grewingk, in his Map of Russian America, assigns the localities of fifty-eight active volcanos on the Northwest Coast of America. They lie in a line running from the north end of Prince of Wales Island, in lat. 56° N, following the course of the coast through the peninsula of Aliaska and the Aleutian Islands. Many of

sandstones are comparatively of small extent." This remark, which I quote from the learned and beautiful work of Professor Dana, 'The Geology of the United States Exploring Expedition under Commodore Wilkes,' will prepare the reader for the examination of a country of a different character from what has above formed the subject of investigation.

The grand features of the country on the Pacific side of the Rocky Mountains arise from the development of three ranges of mountains, intersecting the country in a direction parallel with the general course of the coast-line. Three of these are north and south ranges,—the Coast Range, the Cascade Range, and the Blue Mountain Range. The first lies near the coast, the second 130 miles inland, and the third 350 miles from the sea.

The Cascade Range is much the most extensive of the three, and even rivals the Rocky Mountains in the height of some of its peaks. It may be traced, according to Professor Dana, far into California, and northward into Russian America; retaining throughout a direction nearly parallel with the coast. It terminates northward, according to Grewingk, in the lofty volcano of Mount Wrangell, in lat. 62° N, where it blends with the lateral volcanic range, forming the remarkable promontory of Aliaska. The main body of the Cascade range, in Oregon, is seldom over 5000 or 6000 feet in elevation. [The Sierra Nevada is a continuation of the chain; south it becomes the range of the California Peninsula.]

The Blue Mountains form the western boundary of the Valley of the Snake River (of Lewis and Clarke), flowing into the Columbia. Immediately to the north of this river, as far as Fort Colville, they are interrupted by an extensive level tract; but to the North of Fort Colville there is a range of heights which extends along the north branch of the Columbia River, and may be considered a part of the same general chain.

The short western slope of the continent from the Rocky Mountains to the Pacific differs from the eastern in its river-valleys being all more or less transverse,—the rivers flowing through passes or gorges of the intersecting ranges. The peculiar wing-like projection in the north, towards Asia, is evidently due to the volcanic chain of Aliaska, which runs at right angles to the Rocky Mountains. The great transverse valley of the Yukon

their summits rise into the region of perpetual snow. The line in which the volcanic peaks of Aliaska lie when prolonged to the eastward, strikes the Big Beaver Mountains on the Yukon. On the side of the Atlantic, modern volcanic rocks occur in Jan Mayen's Island only, whose principal mountain, Beerenberg, rises 6870 feet above the sea.

I have been recently informed that the Basquiau Hills, which lie to the south of Cumberland House, on the Saskatchewan River, are volcanic, and that an eruption has been observed there within the last year. The report requires confirmation. No other example is known of the existence of a volcano in any part of America east of the Rocky Mountains.

(the Kwichpack of the Russian geographers) lies to the north of it. The Yukon is a river of great magnitude, probably the largest river in America flowing into the Pacific, not excepting the Columbia. For a considerable part of its course it flows to the North, but afterwards nearly due west, through a country which, as far as can be judged from the descriptive notices of it hitherto collected, closely resembles the valley of the Mackenzie, with some of the affluents of which it is in fact connected: so that here, as in other parts of the Rocky Mountain Chain, the rivers falling into opposite seas interlock at their origin. One or more low chains of mountains, formed by the lateral spurs of the Rocky Mountains, are prolonged along the Arctic Coast, north of the Yukon, giving origin to several small rivers between the mouth of the Mackenzie and Point Barrow.

Oregon Territory.—Our acquaintance with the geology of this district is very limited, and does not extend beyond the portion of country between the Coast Range and the sea, explored by the Expedition of Commodore Wilkes. From Mr. Dana's researches it appears to be occupied chiefly by the tertiary formation, which is found at various places from Puget's Sound to San Francisco along the coast-section of Oregon. The rocks of this formation are soft sandstones, more or less argillaceous and schistose, and clay-shales, either firm or crumbling, together with tufa and conglomerate. The sandstones and shales have been denuded on a vast scale.

The fossils collected by Mr. Dana were examined by the eminent conchologist, Mr. T. Conrad, who assigned them to the geological era of the Miocene. They are comprised in the following list.

Mammal.

1. Vetebræ of a Cetacean.

Fishes.

1. Vertebræ of a species of Shark.
2. —— of a species allied to *Trigla*.
3. ——, cast of; species not distinguishable.

Crustacea.

Callianassa Oregonensis. Balanus.

Mollusca.

Mya abrupta.
Thracia trapezoides.
Solemya ventricosa.
Donax? protexta.
Venus bisecta.
—— angustifrons.
—— lamellifera
—— brevilineata.
Lucina acutilineata,
Tellina arctata.
—— emacerata.
Pectunculus nitens.
Arca devincta.
Cardita subtenta.
Pecten propatulus.
Terebratula nitens.
Dolium petrosum.
Sigaretus scopulosus.
Natica saxea.
Bulla petrosa.
Crepidula prærupta; and sp.
Rostellaria indurata.

Tellina albaria.
—— nasuta.
—— bitruncata.
Nucula divaricata.
—— impressa.
Pectunculus patulus.
Cerithium mediale.
Buccinum ? devinctum.
Fusus geniculus.
—— corpulentus.
Nautilus angustatus.
Teredo substriata.

Echinoderms.

Galerites Oregonensis (n. sp).

Foraminifera, 3 sp.

Plants.

Abies ? robusta; Leaves of Lycopodium ?, Taxodium, Smilax, and others.

The plants were found near the mouth of Fraser's River, and indicate probably the commencement of the deposits of the coal strata, which are largely developed in the neighboring island of Vancouver, and along the coasts and islands of Russian America.*

The interior of Russian America, like that of Oregon, is unexplored; but, in the work of Grewingk (Beitrag zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nord-West Kuste Amerika's), and in the Geological Appendix to Capt. Beechey's Voyage to Behrings Straits, by Dr. Buckland, we have a tolerably complete account of the chief formations occurring along the coast, and on the neighboring islands, from 52° N. lat. to Behring's Straits.

The only representatives of the palæozoic rocks in this part of America, hitherto discovered, are the Mountain limestone, and other members of the Carboniferous series, which are found covering the flanks of the mountains here bordering immediately on the sea, and prolonged into a dense archipelago of volcanic islands, several of them containing active volcanos, which skirt the entire coast from the parallel of 50° northward.

Dr. Grewingk has given in the Transactions of the Mineralogical Society of St. Petersburgh, for 1848–9, a complete list of the organic remains hitherto discovered in Russian America, including those described in the Appendix to Capt. Beechey's Voyage. They afford evidence of the existence of the following formations,—the Carboniferous, Jurassic, Tertiary, and Drift, which have been traced in detached sections along the coast; leaving much still to be desired, however, before a complete and connected view of the geological structure of this portion of the American Continent can be obtained.

Fossils of the Carboniferous Formation.—The limestones of this formation, which have been traced at several points along the coast, are most extensively developed in the NE extremity of the Continent, where they occupy the greater part of the coast-

* For lists of other fossils of Western America collected by Mr. W. P. Blake, see this volume, p. 268.

line from the north side of Kotzebue Sound to within a few miles of Point Barrow, and form the chief constituent of the lofty and conspicuous headlands of Cape Thompson, Cape Lisburn, and Cape Sabine. Near the last-named cape a vein of excellent coal is exposed, which burns with a good heat and a bright flame. The limestone, is according to Dr. Buckland, scarcely distinguishable from the Mountain Limestone of Derbyshire. Some specimens brought to England by Capt. Beechey were found to contain *Lithostrotion basaltiforme* (*Cyathophyllum basaltiforme*, Phil. G. Y.), *Flustra*, *Productus Martini*, *Dentalium*, several varieties of *Terebratula*, and a great abundance of Encrinital fragments, with the detritus of which the rock was in many places almost entirely made up. To these Dr. Grewingk adds, from the collections of Russian explorers, *Cyathophyllum flexuosum*, Goldf., *Turbinolia mitrata*, His., *Cyathophyllum dianthum*, Goldf., and *Sarcinula*, together with some *Spiriferi*, *Orthidæ*, and *Terebratulæ*.

Remains of coniferous plants belonging to the genera *Abies* and *Taxodium*, and of some Ferns, among which is *Neuropteris acutifolia*, have been discovered among the islands along the south coast of Aliaska.

A specimen of *Catenipora escharoides*, found in a rolled fragment on the island of Sitka, would appear to indicate the existence of Silurian deposits in the neighborhood; but no organic remains from rocks of this formation *in situ* have hitherto been discovered.

Jurassic Fossils.—Four fossils found in Katmai Bay, on the south coast of the promontory of Aliaska, have been referred by Dr. Grewingk, on the authority of M. Wosnessensky, Curator of the Zoological Museum of the Academy of Sciences of St. Petersburgh to the Jurassic formation. They include a new species of Ammonite, *A. Wosnessenskii*, *Ammonites biplex?*, Sow., and fragments of *Belemnites paxillosus* and *Unio liassinus*. Mayen (Nov. Act. Phys. tom. xvii, pl. 47, figs. 1 and 2) figures an *Ammonites biplex*, from some Jurassic deposits at the foot of the volcano of Maipu, in the Andes, south of Valpariso, which cannot be distinguished from the specimen from Aliaska. It may be doubted, however, whether upon such scanty evidence the existence of deposits of Jurassic age in these high latitudes, can be considered as established; no other indication of the existence of this formation having been hitherto discovered in any part of North America north of the United States.

Tertiary Fossils.—Traces of the tertiary formation have been discovered at various points between Oregon and Aliaska, but not beyond. This striking and well marked division of the coast may, therefore be considered, in the present state of our information, to be the northern limit of the extensive Tertiary formation along the shore of the Pacific. The fossils enumerated by Dr.

Grewingk include some well-known species of the Tertiary age in Europe; among which may be mentioned *Cardium Grœnlandicum*, Chemn., *C. multicostatum*, *Venerupis Petitii*, Desh., *Mya arenaria*, *Tellina edentula*, Sow., *Astarte corrugata*, *Mytilus Middendorffi*, and *Ostrea longirostris*, Lamk. Some new species of the same genera are added by Dr. Grewingk, together with some forms of *Saxicava*, *Pectunculus*, *Nucula*, *Pecten*, *Crassatella*, and *Venus*.

Fossils of the Drift.—Organic remains of the Pleistocene or Drift Period appear to be much more numerous on the west than on the east side of the Rocky Mountains. The cliffs and sand-banks, wherever they have been examined along the coast, abound with recent shells of the genera *Cardium*, *Venus*, *Turbo*, *Murex*, *Solen*, *Trochus*, *Mytilus*, *Mya*, and *Tellina*. Fossil remains of *Mammalia*, especially those of the Mammoth, are likewise abundant. Teeth of this animal have been discovered on the banks of several rivers north of Mount St. Elias; and there is a celebrated locality at Escholtz Bay, in Kotzebue Sound, where the thawing and wasting of the frozen cliffs is continually exposing the bones and tusks of Mammoths and other quadrupeds. Dr. Buckland, in his interesting account of the specimens collected at this place during Captain Beechey's Voyage, enumerates fragments of bones of Mammoths and of the *Urus*, the leg-bone of a large Deer, and a cervical vertebra of some unknown animal, different from any that now inhabit Arctic America. Along with these were found also the skull of a Musk-ox and some bones of the Reindeer, in a more recent condition than the others. Similar remains including those of the Mammoth, have likewise been discovered, according to Dr. Grewingk, at Cape Nugwuljinunk, at Bristol Bay, and at Norton Sound, as well as in the Pribulon Islands, and lastly at Unalaschka.

The vast profusion of the bones and tusks of the Mammoth in Siberia and the adjacent islands is well known, and it is a somewhat remarkable circumstance that no similar remains have as yet been detected in the corresponding latitudes of America to the east of the Rocky Mountains. None have hitherto been found, according to Sir John Richardson, in the Hudson's Bay Territories, though the annual waste of the banks and the frequent land-slips would have revealed them to the natives or fur-traders had they existed even in small numbers. They are rare also, or altogether wanting, in Canada; but in the Valley of the Mississippi the "bone licks" are well known as most extensive, and as furnishing the remains of many new species of quadrupeds. In whatever way the circumstance may be accounted for, it seems to confirm the opinion to which most American geologists have arrived, that the countries on the eastern and western sides of the Rocky Mountains have been elevated at different periods and under different geological conditions.

ART. XXXIII.—*On the Origin and accumulation of the Proto-carbonate of Iron in Coal Measures;* by Prof. WILLIAM B. ROGERS.*

Proto-carbonate of iron, as is well known, presents itself in the coal measures in courses of lenticular nodules and interrupted plates usually included in carbonaceous shales, and in the fire-clays which underlie the seams of coal, and in such cases it often forms a heavy ore containing but little earthy or organic matter mixed with the proto-carbonate. But it is also frequently met with in a *diffused condition*, pervading thick strata of shale and shaly sandstone, and causing these rocks to present in their different layers all the gradations of composition, from a poor argillaceous and sandy ore, to beds of sandstone and shale, with little more than a trace of the ferruginous compound.

On comparing the different subdivisions of a system of coal measures, we may remark certain general conditions connected with the abundance or with the comparative absence of the proto-carbonate in the strata.

One of these is seen in the fact that *the lenticular ores and strata impregnated with proto-carbonate of iron are in a great degree restricted to such divisions of the carboniferous rocks as include beds of coal or are otherwise heavily charged with carbonaceous matter.* This is well shown on comparing together the four subdivisions of the carboniferous rocks of the great trans-Alleghany coal region, as classified under the head of the Seral coal series of the Pennsylvania and Virginia geology. In the first of these, designated as the *older coal measures*, the proto-carbonate is found in large amount, both in the shape of layers of lenticular ore and diffused through the substance of the shaly strata. In the next division above, distinguished as the *older barren shales*, and which, as the name implies, is comparatively devoid of carbonaceous matter, much less of the proto-carbonate is met with. In the third group, that of the *newer coal measures*, the ore again abounds, and in the uppermost division, or *newer barren shales*, it has a second time almost disappeared.

The connection between the development of the proto-carbonate in the strata, and the presence, either now or formerly, of a large amount of carbonaceous or vegetable matter becomes even more striking on a detailed examination of particular beds. Thus, in the coarse sandstones of the coal measures, which are comparatively destitute of vegetable remains, we find little admixture of the proto-carbonate. On the other hand, the fine-grained, flaggy, argillaceous sandstones, which are often crowded

* From Proc. Bost. Soc. Nat. Hist.

with the impressions and carbonized remains of plants, are at the same time more or less impregnated with this ferruginous compound. So, again, the soft argillaceous shales, in the midst of which the lenticular ore so frequently presents itself, show by their dark color and included impressions of plants, as well as by actual analysis, that they are richly imbued with vegetable matter. Nor do the nearly white fire-clays, which in many cases inclose thick courses of the lenticular ore, form any exception to this law. For although in their present state they contain little or no carbonaceous matter, the marks of innumerable roots of Stigmaria, and parts of other plants which everywhere penetrate the mass, show that at one time they must have been crowded with vegetable remains.

A further and yet more striking proof of the influence which the contiguous vegetable matter has had, in the formation of the proto-carbonate, is seen in the fact, that the most productive layers of the ore are commonly met with quite near to the beds of coal, and that frequently courses of the nodules are found in the carbonaceous shales or partings which lie in the midst of the seam itself.

While the strata including the proto-carbonate are thus distinguished by the admixture of more or less carbonaceous matter, they are *also remarkable for seldom exhibiting a distinctly red tint.* Presenting, where not weathered, various shades of greenish-gray and olive and bluish-black, they only become brown or red where, by exposure to the air, the proto-carbonate has been converted into the sesquioxyd of iron. On the other hand, those divisions of the coal measures which have been but slightly charged with vegetable matter, as for example the barren shales of the Seral coal rocks before alluded to, contain much red material, both in distinct strata and mottling the general mass, and are throughout more or less impregnated with the sesquioxyd.

A like general law as to color would seem to apply to the other great groups of sedimentary rocks, which include in particular beds accumulations of vegetable or other organic exuviæ. Thus, in the New and Old Red Sandstone formations, which generally include so large a proportion of sediment colored by the red oxyd of iron, organic remains are of comparatively rare occurrence, and when present are met with almost exclusively in the gray and olive and dark-colored strata which are interpolated in certain parts of the great masses of red material. This relation is beautifully shown in the middle secondary rocks of the Atlantic slope, which extend in a prolonged belt from the Connecticut Valley into the State of South Carolina. In the strata of red sandstone and shale, which form the chief part of the mass, vegetable or animal exuviæ are almost entirely absent. But where the remains of fish, and impressions of carbonized parts of plants,

do occur in this group of deposits, they are found imbedded in layers of greenish and olive sandstones and dark bituminous shales. So, in the southern parts of the belt in Virginia and North Carolina, where these rocks include seams of coal and extensive beds of sandstone and shale containing the remains of plants, the usual red color is found to give place to the gray, olive, and dark tints of the old coal measures, and layers of proto-carbonate of iron show themselves in the vicinity of the coal seams.

Taken in mass, the red and mottled strata of the unproductive coal measures, or of the other groups of red rocks above alluded to, would no doubt be found to contain, in an equal thickness, as large an amount of iron as the coal-bearing strata which include the layers of carbonate; the difference being that, in the former case, the metal remains for the most part diffused through the rock as a sesquioxyd, while in the latter, having assumed the condition of proto-carbonate, it has to some extent been concentrated in particular layers or strata. According to a rough estimate of the amount of carbonate ore included in the lower coal measures of the Laurel Hill region of Virginia and Pennsylvania, derived from a detailed examination of the ores and associated strata at several points, it may be safely assumed that the equivalent of sesquioxyd of iron would not amount to one third of one per cent of the whole mass of this portion of the coal measures, and a proportion not exceeding this is deducible from the measured sections of ore and accompanying rocks in the carboniferous strata of other tracts subjected to a similar calculation.

But even allowing a quantity three times as great as this, to cover the diffused carbonate and the oxyd in some cases mingled with it, we should have only about one per cent to represent the proportion of ferruginous matter in the entire mass; an amount undoubtedly much less than exists in many of the strata of red and purple shales and shaly sandstones of the carboniferous series or of the groups of red rocks geologically above or beneath it.

In attempting to explain the origin of the proto-carbonate, under the conditions above described, it is important to keep in view the fact of the diffusion of this compound through many of the strata as a general constituent, and the frequent preservation, even in layers of the ore, of the lamination of the contiguous rock. The supposition of its being a chemical deposit formed from springs charged with carbonic acid, and holding proto-carbonate in solution, is evidently inconsistent with these conditions, and not less so with the fact of the great horizontal extension of individual beds of ore and impregnated shaly rocks.

In view of these various considerations it may be concluded:—

First, That throughout the coal measures and other groups of rocks above mentioned, as well in the portions containing coal

and diffused vegetable and animal matter as in the barren parts, the original sediment was more or less charged with sesquioxyd of iron; and

Second, That this sesquioxyd, in the presence of the changing vegetable matter with which certain of the strata abounded, was converted into proto-carbonate, which remained in part diffused through these beds, or by processes of filtration and segregation was accumulated in particular layers.

It is well known that during the slow chemical changes by which vegetable matter inclosed in moist earth is converted into lignite, or coal, both light carburetted hydrogen and carbonic acid are evolved, and that these gases are even eliminated from coal seams and their adjoining carbonaceous strata. The reducing agency of the carbon and hydrogen, as they separate in their nascent state from the organic matter, is capable, as we know, of converting certain sulphates into sulphurets, and even more readily of transforming the sesquioxyd of iron into protoxyd. The latter change would doubtless be favored by the affinity of the carbonic acid present in the mass, for the protoxyd as formed, and in this way the sesquioxyd, would be entirely converted into the proto-carbonate of iron.

Conceiving a like process to have operated on a large scale in the coal measures or other strata containing, when deposited, a mixture of sesquioxyd of iron and organic matter, we have a simple explanation of the general conversion of this oxyd into carbonate, and of the loss of the reddish coloring in which these materials more or less participated. As these actions must be supposed to have commenced in each stratum as soon as the organic matter contained in it began to suffer chemical change, we may conclude that the formation of the proto-carbonate was already far advanced in the earlier strata when only beginning in those deposited at a later period. Each layer of vegetable matter, as it was transformed into coal, would not fail to impregnate the adjoining beds of shale and sandstone with the proto-carbonate, and thus the development of this compound was as it were coeval with that of the coal.

The gathering of the diffused proto-carbonate into bands and courses of ore began no doubt as soon as the production of this compound had made some progress, but it probably continued until long after the completion of the chemical changes above described; and indeed, it is possible that in some strata it is not yet entirely finished. In this process, which finds a simple explanation in *the combined action of infiltration and the segregating force*, it can hardly be questioned that *the carbonic acid*, pervading the mass of sediment, acted *a very important part*. The large amount of this gas evolved from the beds of vegetable

matter undergoing change, would impart to the water of the adjoining strata the power of dissolving the diffused proto-carbonate, which, being then carried by infiltration through the more porous beds, would accumulate above and within the close argillaceous or shaly layers, forming in some cases bands of rock ore, in others courses of nodular and plate ores. Of these, the former would seem to have resulted from the accumulation by *gravity* of the dissolved carbonate in the substance of sandy shales near the upper limit of the more impervious beds, while we may regard the latter as having been collected in all directions from the general charge of proto-carbonate accumulated in the argillaceous mass, its mobility in the dissolved condition greatly aiding the gathering process of the *segregating force.*

Art. XXXIV.—*Subdivisions of the Palæozoic Strata of Great Britain, according to Prof. Sedgwick.**

I. *Lower Palæozoic Division, representing the Cambrian and Silurian Series in ascending groups.*

Cambrian Series.	1. Longmynd and Bangor group (Lower Cambrian)	*a.* Longmynd slates, &c. *b.* Llanberris slates; alternations of roofing-slates and grits. *c.* Harlech grits; sometimes approaching a conglomerate form.
	2. Festiniog group (Middle Cambrian)	*a.* Lingula flags. *b.* Tremadoc slates. *c.* Arenig slates and porphyries; Festiniog slates; slates, flags, and grits; indefinite alternations of porphyry and trap-shale: one irregular band of limestone near the top of the group. Thickness great.
	3. Bala group (Upper Cambrian)	*a.* Lower Bala rocks. (1) A great zone of dark and sometimes earthy slate. (2) A great series of slates, flags, and grits, ascending to the Bala limestone. *b.* Upper Bala rocks. Under this term are included—(1) the Bala and Hirnant limestone and the Llandeilo calcareous flag—(2) Flag-stones, slates, calcareous beds, and shelly sandstones of Caer Caradoc. The whole series ending, in North Wales, with slate and flagstone; and in South Wales, with slates, grits, and coarse conglomerates. The group of very great thickness.

Immediately above these three groups there is a great change of physical conditions. The most characteristic and abundant

* Extracted from the great work on The British Palæozoic Rocks, by the Rev. Adam Sedgwick, M.A., F.R.S., &c., and on British Palæozoic Fossils, by Professor Frederick M'Coy, F.G.S., &c., 4to, London, 1855, briefly noticed at page 302 of this volume.

of the older organic types disappear, and new types take their place. The sections are usually broken and discontinuous; and the upper (or Silurian) groups sometimes overlap the lower (or Cambrian) groups unconformably. Here, therefore, (to adopt a language in common use), we have the commencement of a new *system*. Without counting the vast thickness of the Longmynd slates, the thickness of the Cambrian series, where well developed, is, I think, more than 25,000 feet.

Lower Palæozoic Division continued.

Silurian Series.	1. Wenlock group	*a.* May Hill sandstone; Pentamerus (or Norbury) limestone.
		b. Woolhope (or Lower Wenlock) limestone.
		c. Wenlock shale.
		d. Upper (or great) Wenlock limestone.
	2. Ludlow group	*a.* Lower Ludlow rock.
		b. Aymestry limestone.
		c. Upper Ludlow rock.
		d. Tilestone.

The aggregate thickness of the series about 5000* feet.

The introduction of the May Hill sandstone as a part of the Wenlock group is the only important change I have made in the corresponding portion of the "Tabular View" which is prefixed to the "Second Fasciculus of the Cambridge Palæozoic Fossils." It gives a true physical and palæontological base to the Silurian series: and assuredly there is not (under this arrangement) any such thing in nature as a "Middle Silurian Group," which inseparably links together the Cambrian and Silurian series, and makes them into one system. The May Hill subgroup is not unfrequently discordant to the older groups, on which it rests; and its fossils unite it unequivocally to the Wenlock group. It must therefore, both on physical and palæontological evidence, be cut off from the shelly sandstone of Caer Caradoc and Horderly; to which it is discordant in position, and with which its palæontological relations are not comparatively so near as to the Wenlock group. It is in fact, as now given in the Table, an integral portion of the Wenlock group.

* I obtain this number from an estimate of the thickness of the "Upper Silurian" rocks, by Dr. Fitton, added to the thickness of the May Hill sandstone, as given by Professor Phillips. Aggregates of this kind are frequently too great. For, as a general rule, where one of a set of connected groups rises above the average thickness, another group will probably descend below it. For example. The Woolhope limestone of Presteign is a noble rock, but the Wenlock limestone is quite degenerate. At Wenlock the limestone forms a grand terrace, but the Aymestry limestone has almost vanished. At Leintwardine the Aymestry limestone is a grand rock, but the Wenlock limestone is degenerate. Many other examples might be quoted.

Lower Palæozoic Division as developed in the Cumbrian mountains of the North of England.

Equivalents of the Cambrian Series.	1. Skiddaw slate (Lower Cumbrian)	A group of vast thickness, and probably admitting of several subdivisions. In some of its upper beds a few graptolites and fucoids have been found. Generally it is without a trace of fossils. Near the granite of Skiddaw Forest entirely metamorphic. It is the supposed equivalent of the Longmynd slate (1 *a*) of the Cambrian series.
	2. Chloritic slate and porphyry (Middle Cumbrian)	A group of enormous thickness, composed of alternating masses of slate, sandstone, porphyry, porphyritic conglomerate, trap-shale, &c. &c. It forms no passage into the Skiddaw slate, and is sometimes separated from it by trappean conglomerates. The conglomerates become attenuated, and pass into trap-shales (*schaalstein*); and the shales pass into roofing-slate. The alternations are innumerable. The great deposits of slate are good mineral equivalents of the Llanberris and Festiniog slates. The group seems to pass, at one extremity, into the calcareous slates of the Coniston group; and (when taken collectively) may be considered as the equivalent of all that part of the Cambrian series which extends from the Llanberris and Bangor slates to the Lower Bala rocks inclusive.
	3. Coniston group (Upper Cumbrian)	*a.* Coniston limestone and calcareous slate. *b.* Flagstone; generally calcareous.*

The Coniston limestone appears to be the exact equivalent of the Bala limestone both in its mineral type and in its group of fossils; and the Coniston flagstone seems to represent (in a very degenerate form) the slate, flags, grits, shelly sandstones, and coarse conglomerates which in North and South Wales overlie the Bala limestone and the Llandeilo calcareous flagstone.

* While the May Hill sandstone was confounded with the Caradoc group, and the Coniston limestone and flagstone were confounded with the Caradoc sandstone and Wenlock shale, the Coniston grits appear to be quite anomalous among the true Silurian groups: but now that these grits have found their right place, the anomaly ceases altogether. They produce a remarkable impress on the physical features of the Silurian country of the North of England; and spite of their general sterility, they make a noble exhibition of the May Hill sandstone, and thus form the natural base of the Silurian series of the Cumbrian mountains.

There never was any real difficulty in the natural succession of the physical groups of Cumberland and Westmoreland; and I could have described this succession, in 1824, as well as, perhaps better than, it is given in this Tabular View. The only subsequent difficulty was in attempting to put the successive groups into coordination with those of Wales and Siluria; and so long as the sections, the fossil lists, and the nomenclature of the "Lower Silurian" rocks were taken as a key, the confusion among the groups was inexplicable; simply because the key was false to nature. But the moment the so-called "Silurian key" was thrown aside, the Coniston limestone naturally fell into the place I had first given to it. It became the equivalent of the Bala limestone; and the whole succession became, once more, perfectly natural, both on physical and palæontological grounds.

Equivalents of Silurian Series.

1. Coniston grits.
   - A thick group composed of hard siliceous sandstone, in some places of very coarse texture, and passing into a conglomerate form. It is very sterile of fossils, and the few which have been found give no decisive evidence as to its epoch. Without any obvious discordance of position it marks the commencement of a great change of mineralogical type; and immedintely above it we find the commencement of a newer Fauna. It much resembles the sterile portions of the May Hill sandstone, and it appears to have the same place in the general series.

2. Ireleth slate-group of great thickness.*
   - *a.* Lower Ireleth slate: coarse, and seldom applied to use as a roofing-slate.
   - *b.* Ireleth limestone; concretionary and discontinuous; a few very obscure fossils.
   - *c.* Upper Ireleth slate. Many subordinate beds of grit, and many alternations; largely quarried.
   - *d.* Coarse slate and grit; seldom quarried for roofing-slate.*

3. Kendal group.
   - *a.* A great group of flags, grits, &c.; beds without good transverse cleavage. North side of Kendal Fell and Valley of the Kent. Fossils abundant; prevailing type Lower Ludlow.
   - *b.* Grit, sometimes in thick beds, and of coarse texture; flagstone; bands of coarse slate, generally without transverse cleavage; fossils in certain beds abundant, and of the Upper Ludlow type. The moors SE of Kendal.
   - *c.* Tilestone, resembling that described in the "Silurian system;" fossils abundant, and of the Upper Ludlow type.

Collectively, the above series (from the Coniston grits to the Kendal group inclusive) is of very great thickness; yet, being almost without any subordinate beds of limestone, it is not so prolific of fossils as the corresponding groups in Siluria.

There are in the Woodwardian Museum, I believe, 166 ascertained species collected from the groups between the Skiddaw slate and the tilestone inclusive; and when these species are divided into *two groups*—the *upper* representing all the known fossil species down to the base of the Coniston grits, and the *lower*, all the known species below the Coniston grits—the two groups are found to have but five species in common. In other words, between the Cambrian and Silurian series in the north of England, there are not more than about three per cent of common species, and some of those belong to types which are not confined to the Lower Palæozoic Division.

The whole Silurian series of Westmoreland is overlaid by unconformable and discontinuous masses of red conglomerate; generally of very coarse structure, but sometimes passing into red

* The Ireleth slate-group is spread over a wide extent of country, and is of great thickness, and its fossils, though generally rare, are of the Wenlock type. In the sub-group (*d*) some of the fossils seem to belong rather to the Ludlow rocks; among which the *Hemithyris navicula* is in great abundance. This sub-group seems to pass into, and to be blended with, the sub-group (*a*) of the higher, or Kendal, group.

sandstone. These masses are the degenerate representatives of the Old Red Sandstone. Among the imbedded pebbles we find both Cambrian and Silurian fossils; and on the upper surface of the older rocks (whether Cambrian or Silurian) on which the conglomerates rest, are remarkable examples of mechanical abrasion.

II. *Middle Palæozoic Division.*

Devonian Series or Old Red Sandstone.

(1.) *In Herefordshire and South Wales.*

1. Cornstone group, - - - *Cephalaspis*, &c.
2. Red sandstone and conglomerate, *Holoptychius*, &c.

The aggregate thickness eight or nine thousand feet.

(2.) *In Devonshire and Cornwall.*

1. Liskeard or Ashburton group.
2. Plymouth group.
   - *a.* Great Devon limestone.
   - *b.* Calcareous slates.
   - *c.* Coarse red sandstone and flagstone.
3. Dartmouth slate group. Coarse roofing slates and quartzites; ending in North Devon, with beds of red, green, and variegated sandstone; analogous structure in South Devon.
4. Petherwin (or Barnstaple) group.
   - *a.* Marwood sandstones.
   - *b.* Petherwin slate and *Clymenia* limestone; calcareous slates of Barnstaple.

The agregate thickness of this series is very great, but is not computed.

In Devon and Cornwall the above series has no base; and we are without any evidence as to the beds which are below the lowest Devonian group. Hence there is much uncertainty in the co-ordination of the series of Herefordshire with that of Devon and Cornwall: for the Herefordshire cornstone has characteristic fishes without characteristic shells and corals; while the Devonshire and Cornish series has characteristic shells and corals, but is without fishes.

In a former scheme the Liskeard and Plymouth groups were united; but they may, I think, be conveniently separated. The Herefordshire fish-beds (cornstone) I had formerly placed over the Plymouth group, on the understanding that certain supposed fish-beds of Cornwall were probably of the age of the Dartmouth group. But the Cornish fish-beds having now disappeared from the sections, I think it much the *safest plan* to place the Cornstone group below all the groups of Devonshire; especially as it seems in some places to pass downwards into the tilestone of the Ludlow group, and therefore *appears to give us* (what we do not find in Devon and Cornwall) a base to the Devonian series. On this hypothesis we might arrange the Devonian series of Herefordshire and the sub-groups of the Silurian series in a regularly ascending and unbroken numerical order; but the numerical series would be defective in its last term. The phenomena in Scotland seem however to be adverse to this hypothesis.

The Petherwin (or Barnstaple) group is *provisionally* arranged in the Devonian series. Physically, it is best connected with the older groups of Devonshire and Cornwall; but *palæontologically*, it is perhaps better connected with the rocks of the Upper Palæozoic division.* Here, therefore, there seems to be a *continuous ascending order of deposits*, and a *passage* from the Devonian series to the Carboniferous.

(3.) *Devonian Series of Scotland.*

Grand as is the development of the Old Red Sandstone of Herefordshire, it dwindles into insignificance when compared with the rocks which pass under the same name in Scotland. They are divided by Miller as follows:—

Devonian Series.

1. Great conglomerate and red sandstone.
2. Bituminous schists—*Dipterus*, *Pterichthys*, *Coccosteus*, &c.
3. Red and variegated sandstone.

These three groups make up the "lower formation" of Miller, and are well seen in Caithness.

4. Gray sandstone, earthy slates, &c. This is the "middle formation" of Miller, and contains a peculiar group of fishes, *Cephalaspis*, &c.
5. Red sandstone and conglomerate.
6. Impure concretionary limestone.
7. Yellow siliceous sandstone.

The last three, called by Miller the "upper formation," are characterized by *Holoptychius*, &c.

This vast North-British series has no true palæontological base; but its "upper formation" seems to graduate into the Carboniferous series.

Its lower groups have no known representatives in the Old Red Sandstone of Herefordshire, and cannot (with our present information) be drawn into a close and unequivocal comparison with the "*tilestone*" and fish-beds of the *Ludlow rock*. But its "middle and upper formation" seem to be represented, though imperfectly, by the "cornstone" and overlying conglomerates, &c. of Herefordshire. From this also it seems to follow, that the upper part of the Old Red Sandstone of Herefordshire is defective in its development; and the conglomerate form of its upper beds appears to sanction the conclusion. If this conclusion be received, it will follow that the Devonian series of Herefordshire is defective at its upper extremity, while the same series in Devon and Cornwall is defective at its base.

But if we take the Devonian series of Scotland as our type, a still more remarkable conclusion seems to follow: viz., that the Devonian series of Herefordshire (spite of its apparent passage into the tilestone) is *also defective at its base*. For we have little or nothing in Herefordshire to match the first three great groups, or "lower formation," of Miller. May we not, however,

* This question is discussed in a paper on the Slate Rocks of Devon and Cornwall, Quarterly Journal of Geol. Soc., vol. viii, 1852.

suppose that this "lower formation" actually descends below the Old Red Sandstone of England, and is on the parallel of the tilestone and fish-beds of the "Silurian system?"

III. *Upper Palæozoic Division including the Carboniferous and Permian rocks.*

Carboniferous Series.

1. Great scar-limestone: coal-field of the basin of the Tweed, and lower coal-field of Scotland. Under this group may, perhaps, be finally arranged the "Carboniferous slates" of Ireland, and also the Marwood and Petherwin groups above mentioned. The coal-field of the Tweed appears to include the "great scar-limestone" of Derbyshire and Yorkshire, and even to descend below it.
2. "Limestone shale" of Derbyshire, "Yordale series" of Phillips.
3. Mill-stone grit. A deposit variable in structure and thickness; seldom entirely wanting; in Yorkshire, a complicated group of great thickness, and containing beds of coal.
4. Great upper coal-field of England, to be divided into two or three sub-groups.

Upper Division continued.

Permian or Dolomitic Series.

1. Coarse red sandstone and conglomerate, generally unconformable to the Carboniferous strata. It contains (though rarely) true Carboniferous fossils (*Lepidodendra, Stigmariæ*, &c.), which may, perhaps, have been drifted mechanically out of the contiguous coal-fields into this coarse, overlying, Permian sandstone.
2. Marl-slate, and thin-bedded compact limestone; a few impressions of plants; shells of Palæozoic genera—*Productus, Spirifer;* some *Lamellibranchiata;* many impressions of fishes—*Palæoniscus, Platysomus, Pygopterus, Acrolepis*, &c.
3. Magnesian limestone, in some parts of the north of England of great thickness, and most complicated structure: *e.g.* rarely a crystalline dolomite, compact, cellular, earthy, brecciated, globular, oolitic, &c., occasionally with organic remains—*Productus, Spirifer;* several *Lamellibranchiata; Synocladia, Fenestella*, &c.
4. Red gypseous marls, very slightly saliferous.
5. Thin-bedded gray limestone, sometimes cellular and dolomitic. A few traces of bivalves, &c.
6. Red gypseous marls. The above series is overlaid by the great red and variegated sandstone which forms the base of the *Trias*.

The preceding six groups are derived from the sections of Yorkshire and Durham, where the series is best developed. It is evident from the description of these groups, as well as from their general want of conformity to the carboniferous groups, that the Permian series of England is *physically* more nearly connected with the Triassic than with the Palæozoic rocks. But its fossils (even without including the undoubted carboniferous plants which have been found in the first group) are of a decided Palæozoic type—a fact which greatly astonished me when I examined the magnesian limestone groups more than thirty years since. If we adopt the term Permian, as a general designation of the series, it must be done with proper limitations derived from the English types. For to class under the Palæozoic name, Permian, the red sandstone of St. Bees' Head, or the great red sandstone of central England, would, I think, be perfectly erroneous. It would be the sacrifice of a natural and well-estab-

lished sequence of the British deposits to the consistency of a newly adopted foreign name. On this account we have, I think, been premature in using the term Permian to define a British series, which appears not to be quite co-ordinate with the Permian series of Russia. The English type is in fact better, for the purpose of European comparison, than the Russian; and where we have a good and unambiguous English type it is an injurious anomaly, in the present condition of our nomenclature, to introduce a foreign name into the English series.*

In the south of England the whole series is sometimes represented by a mass of conglomerate. In central England, Warwickshire, &c., it is represented by a coarse red sandstone, some beds of which become calcareous; and the whole group is conformable to, and appears to pass into, the coal-measures. About the commencement of the Triassic period, these Permian sandstones underwent contortions along with the coal-strata; in consequence of which we see, in Warwickshire, the upper Triassic groups resting discordantly upon the inclined beds of these sandstones.

In conclusion we may remark,—

1. That it is not in all cases an easy matter to draw a clear line between this series and the carboniferous. Thus Mr. W. Smith, in his old geological map of Yorkshire, considers the lowest group (No. 5) as one of the coal-measures. The series most frequently commences with a discordancy of position and a co-ordinate change of organic types. With limited exceptions, the *flora* and *fauna* of the Permian groups differ from those of the Carboniferous period.

2. The several groups of the series admit of a very close comparison with the *Rothe-todte-liegende*, the *Kupferschiefer*, and the *Zechstein*, &c. of Germany.

General Conclusions.

On casting the eye over the above short Synopsis, or Tabular View, of the whole Palæozoic series, several conclusions seem to force themselves on any well-informed reader: and I will enumerate them here, though they involve a partial repetition of what has been stated above. A more detailed discussion of them will, I hope, before long form the subject of another essay.

First. There is a frequent difficulty in separating the collective groups, such as the Cambrian, Silurian, Devonian, &c., by

* The present nomenclature of the British groups, from the oldest Palæozoic to the newest Tertiary, is essentially geographic and local. The *Pomfret Series* would be a far better, and a far *less ambiguous* name for the English dolomitic series than the name *Permian*. The name Pomfret series (or system) would moreover connect the nomenclature with that of Mr. W. Smith, as recorded in his old map of Yorkshire, 1821. We have, however, done right in adopting one foreign designation, *Trias;* because in that part of the general series the English type is singularly defective.

well-defined lines of demarcation: and this difficulty is very little affected by our nomenclature; for it obviously remains the same, by whatever names we describe these collective groups. But the Cambrian series is now, physically and palæontologically, well separated from the Silurian by the intervention of the May Hill sandstone. Commencing with the May Hill group there is a sudden change of mineral type, and an obvious physical break, sometimes marked by a change of strike and clear discordancy of position; and along with these changes there is also a sudden (and almost complete) suppression of the *most abundant and characteristic* of the older organic types. So far as regards the evidence supplied by Wales, and the bordering English counties, and by the north of England, the question respecting this line of demarcation is, I think, perfectly set at rest: nor does there appear to be anything in the development of the older Palæozoic series of the continents of Europe or America which is opposed to this conclusion.

Secondly. The Silurian groups, from the May Hill (or Wenlock) sandstone to the upper Ludlow rocks inclusive, are by no means so well separated from the old red sandstone (or Devonian rocks) of Herefordshire and South Wales. The old red sandstone was subdivided by Buckland and Conybeare into the Tilestone group, the Cornstone group, and the red sandstone and conglomerate group; and this triple division, with many new and important additional details, was adopted in the "Silurian system." Chiefly on the combined physical and fossil evidence supplied by the corresponding groups of Westmoreland, this triple division of the old red sandstone was afterwards abandoned. The Tilestone was struck off from the Devonian series, and placed at the top of the Silurian. There is, therefore, in the typical Silurian country such a graduation or passage between the Silurian and Devonian groups as to place a physical difficulty in our way when we attempt to draw a line between them. This line, as it is drawn at present, might, however, be considered as very well fixed and determined, were it not for the enormous development of the old red sandstone of Scotland, which (as before hinted) seems to descend below the base line of the Devonian series of Siluria. And when we bear in mind that fishes begin first to appear in the Upper Silurian groups, and become eminently characteristic of the Devonian, we seem (through this vertebrate class of the animal kingdom) to make out a nearer connection between the Silurian and Devonian groups than was at one time imagined.

I am here discussing no evidence but what is supplied by British rocks; and assuredly the classification of British rocks should, in the first instance, be based on British evidence. But I may remark, by the way, that the lower Devonian groups of

the continent (e. g. those of the Rhenish provinces) seem to run into an intimate union with the Silurian. Hence it appears to me by no means improbable that we may be hereafter induced (provided we continue to separate the whole Palæozoic system, as in the Tabular View, into three primary divisions) to place the Silurian series not in the *lower*, but along with the Devonian series in the *middle division* of Palæozoic rocks. I only throw this out as a mere hypothesis; and if it be hereafter adopted, it must be on a wider base of evidence than is at present supplied by the Palæozoic system of England.

Thirdly. Though the Devonian series, of the Herefordshire type, seems to pass downwards into the Upper Silurian groups, it does not appear to pass upwards into the Carboniferous. There is generally a palæontological and physical gap between them, which is in many places obscurely indicated by the upper conglomerates of the old red sandstone. Now this gap is, if I mistake not, filled up by the higher Devonian groups in Cornwall and Devonshire. In those counties, when we draw a line between the Devonian and Carboniferous rocks, we find the physical and palæontological evidence in positive conflict. For if we go on the single principle of counting species the Petherwin and Barnstaple groups (as was, I believe, first pointed out by Mr. Griffith on the specific determinations of Professor McCoy) must be packed with the Carboniferous series. But in so doing we deprive of all importance a grand group of dark slates and flags, which seem to have been laid down by nature's hand as the true and continuous base of the great Culm-trough of Devonshire and Cornwall. Nor is this all. The Petherwin and Barnstaple groups, along with many true Carboniferous types, contain several genera and species which have not hitherto been considered as Carboniferous. In such a case as this we may strike a balance in the conflicting weight of evidence offered by the groups, by giving them an undefined margin, and by adopting a provisional nomenclature.*

* The case of the Old Red sandstone of the north of England has not been prominently noticed. It generally appears (as above stated) in the form of a very coarse conglomerate, which, if I mistake not, represents *only the upper part* of the Devonian series. In following the base of the Carboniferous rocks (as they wind round the Cumbrian mountains) we in several places find them underlaid by a coarse red conglomerate, and in a few places both by red conglomerate and red sandstone. In the latter case (e. g. in the neighborhood of Shap Wells) the beds of red sandstone are perfectly parallel to the overlying beds of the great scar-limestone. Nor is this all. Beds of red sandstone, of an identical mineral type, alternate, in thick masses, with the beds of the great scar-limestone; as may be seen in several places in the fine sections between Ravenstone Dale and Shap, and thence into Cumberland. In all such cases there is obviously an intimate union between the Old Red and Carboniferous series—a fact which seems to sanction the opinion that the Old Red conglomerates of the north of England represent only the upper part of the Devonian series.

Fourthly. There is in like manner, in some localities, a great difficulty in drawing the demarcation between the Carboniferous and Permian series. This difficulty was acknowledged by Smith in his old geological map of Yorkshire,* in which he classed the "*lower red sandstone*" (or *Permian sandstone* of a more modern nomenclature) as one of the coal-measures. The difficulty was also fairly stated by myself in a paper (founded on independent observations made in 1821, 1822, and 1823) published in the "Transactions of the Geological Society;" in which, on *physical grounds*, I classed the magnesian limestone (now called Permian series) with the new red sandstone (now Triassic) series; while on *palæontological grounds* it was far more nearly connected with the Carboniferous.

Nor did the progress of discovery remove this difficulty: for near Whitehaven many true carboniferous fossil plants have been found in the Permian sandstone which underlies the magnesian limestone; and similar fossils have also, I believe, been found in the Permian sandstone of Yorkshire.

Again, as a prevailing rule, both in the northern and south-western English counties, the Permian groups (as before stated) are unconformable to the carboniferous. But in central England this rule fails. Thus, in the coal-fields north of Coventry there is a fine Permian sandstone which is perfectly conformable to the coal-strata, partakes of their accidents, and appears to pass into them.† On the contrary, it is overlaid discordantly by the gypseous marls, sandstones, &c. of the Triassic group.

Fifthly. There is a similar difficulty is drawing a fixed line of demarcation between the Permian and Triassic groups. In Yorkshire, where the Permian series is most perfectly developed, its upper beds are parallel to, and (through some red gypseous beds) seem to form a good mineral passage into the Triassic series. And on the coast of Cumberland, geologists are not agreed where to draw the line between the two great groups—Permian and Triassic. Sir R. I. Murchison has drawn the line above the red sandstone of St. Bees' Head. I think this is a mistake, and that the line ought to be drawn below that red sandstone; which is, I believe, the equivalent of the *Bunter sandstein*, or *Grès rouge* of the *Trias*.

After the remarks above made (under the five preceding heads) let no one suppose that I have any wish materially to change the

* A work not without some errors, but of *very great merit* considering the early date of its publication (1821).

† The words "to pass" may, perhaps, be considered inaccurate, when it is added, that (in the coal-fields alluded to) the Carboniferous series is separated from the Permian sandstone by one, and sometimes two, thin bands of limestone (exactly like the thin bands described in the Silurian system, in the same geological position) which are supposed to be of freshwater origin. Whatever be their origin, they are (in the country alluded to above) associated with true carboniferous plants.

nomenclature of the Palæozoic series as sketched in the Tabular View. Whatever may become of the three divisions of the Palæozoic series—whether they be retained as they are, or admit of a new adjustment—very little affects any important question of classification and nomenclature: but I see no ground for anticipating that the subdivisions into Cambrian, Silurian, Devonian, Carboniferous, and Permian, will ever require any material change or adjustment: at least so long as we continue to adopt a geographical nomenclature, which is based on the actual succession of physical groups and is fortified and defined by a co-ordinate weight of fossil evidence. Nor does it much matter by what names we call these several subdivisions. Whether each is to be called a *system* or a *series*, seems, at first sight, rather a question of taste than of science. I think, however, that the facts just stated do prove that the word *series* is a more correct description of the Palæozoic subdivisions than the word *system*—among other reasons because it is a less definite term, and admits of a broader margin: and to this reason we may now add, with perfect certainty, that the abuse of the word system has been a drag-chain on British Palæozoic geology, and has led to many and great mistakes, both in classification and nomenclature.

Sixthly. To the previous remarks I may add, that if the succession of our geological deposits were physically complete, we might, with proper caution, apply the percentage theory of Sir Charles Lyell to their limitation and nomenclature, by counting the well-ascertained species in each successive group. But in the actual condition of our palæontological series we cannot follow this rule, universally, without introducing the elements of confusion. Thus on the percentage theory, we should unquestionably be led to give a false date to the Red Crag of Suffolk; for this simple reason, that a great number of its fossils have been mechanically drifted out of an older deposit, the Coraline Crag—a fact first clearly pointed out by Mr. Charlesworth.

There *may not* be a similar example in the whole British Palæozoic series: but assuredly it is *not improbable* that among the coarser and more mechanical Palæozoic deposits (such as the red sandstone which overlaps the carboniferous rocks and forms the base of the Permian series; or such as the coarse mechanical beds of the May Hill sandstone, which, in like manner, overlap the Cambrian rocks, and form the base of the Silurian series) there *may* be some examples of species which have drifted out of the rocks of an earlier date. On this ground, while we are making a comparative estimate of the Cambrian and Silurian faunas, we can only count at a very low value such species as abound in the lower, and appear *very rarely* in the upper division; and appear *there* only within a very little distance of the line of demarcation between the two. To count such species

of the same numerical value in the two faunas, would be as gross an instance of miscalculation as could well be imagined.

Seventhly. Without dwelling on cases of *immediate ambiguity*, we may affirm generally—that when we profess to give a comparative estimate of the fauna of any two Palæozoic groups, we have no right to overlook the question, whether certain species belong to a prevailing type in one of the groups; or, on the contrary, are rare (and perhaps doubtful) exceptions. I will take, for example, six species which are given by the author of "Siluria" as common to the Llandeilo, Wenlock, or Ludlow formations; viz. *Tentaculites anulatus*, *Petraia elongata*, *Trinucleus concentricus*, *Leptæna sericea*, *Orthis Actoniæ*, *Orthis vespertilio*. This list might be largely increased; but I select these six species for a reason given below. In many parts of the Cambrian series they are found in millions: and they produce a very characteristic impress on its fauna. But not so much as a single unequivocal fragment of any one of them is to be found in those parts of the Cambridge collection which are derived from beds below the May Hill sandstone. Negative facts cannot stand a moment against positive. This we all allow: but if negative facts be honestly and laboriously stated, they *may*, at least, prove that certain positive facts (such as the six examples above quoted of species common to Cambrian and Silurian rocks) are *very rare* and *exceptional* cases. Such cases are not to be received but on evidence that is unequivocal; viz., the production of the very species upon which the exceptional lists have been formed. Now I was informed by Professor McCoy (in a note which is now before me) that he had applied, at the Museum of Economical Geology, for a sight of five, out of six, of the very species above enumerated, and that not one of them was shown to him, or found in the Museum, under conditions which confirmed the assertion that they were common to Llandeilo, Wenlock, or Ludlow rocks. As to one of the six species (*Orthis Actoniæ*) I myself applied to Prof. Forbes for his authority. He replied that he could not give his sanction for this species as a type common to the (so-called) Upper and Lower Silurian rocks—that he had nothing but a field memorandum respecting it, and that he might very easily have mistaken the species, or mistaken the rock from which it was obtained.

Taking Sir R. I. Murchison's list, as published in the appendix to his "Siluria," and without any deduction whatsoever, it does not give us much more than ten per cent of species common to true Cambrian and true Silurian British rocks. But when we have struck out from this common list, (1.) all those species which range beyond the limits of the lower Palæozoic division, into the Devonian and Carboniferous groups; (2.) all species of doubtful authority; (3.) all species of which the geological place

is not established on good physical evidence; (4.) all species which however abundant in the *lower series* disappear in the *upper*—either altogether, or ascend into it through so very limited a space above the line of demarcation as to produce no general impress on the upper fauna;—when all this has been done, I have no doubt that the number of *common species* will fall *considerably below ten per cent:* perhaps as low as the percentage shown by the Palæozoic series of North America or Bohemia; but not so low as the per centage shown by the Cambrian and Silurian rocks of the north of England.

ART. XXXV.—*New method of disintegrating masses of Fossil Diatomaceæ;* by Prof. J. W. BAILEY.

MANY masses of fossil Diatomaceæ are so strongly coherent, that they cannot be diffused in water, (for the purpose of mounting in balsam,) without a degree of mechanical violence which reduces to fragments many of the most beautiful and interesting forms. This is particularly the case with some specimens from the "infusorial deposits" of California. Some of these I endeavored to break up, by boiling in water and in acids, and also by repeated freezing and thawing when moistened, but without good results in either case. At last it occurred to me that the adherence might be due to a slight portion of a siliceous cement which the cautious use of an alkaline solution might remove without destroying any but the most minute shells of the Diatoms. As the case appeared a desperate one, a "heroic remedy" was applied, which was to boil small lumps of the diatomaceous mass in a strong solution of caustic potassa or soda. This proved to be perfectly efficacious, as the masses under this treatment rapidly split up along the planes of lamination, and then crumbled to mud, which being immediately poured into a large quantity of water ceased to be acted upon by the alkali, and gave when thoroughly washed, not only all the large shells of the Diatoms in a state of unhoped for perfection, but also furnished abundance of the minute forms. Having obtained by this method highly satisfactory results from specimens from many localities I can confidently recommend it as an addition to our modes of research.

The following directions will enable any one to apply the process. Put small lumps of the mass to be examined into a test tube, with enough of a solution of caustic potassa or soda to cover them; then boil over a spirit lamp for a few seconds, or a few minutes, as the case may require. If the solution is sufficiently strong, the masses will rapidly crumble to mud, which must be poured *at once* into a large quantity of water, which after subsi-

dence is removed by decantation. If the mass resists the action of the alkaline liquor a still stronger solution should be tried, as while some specimens break up instantly in a weak solution of alkali, others require that it should be of the consistence of a dense syrup. The mud also should be poured off as fast as it forms, so as to remain as short a time as possible in the caustic ley.

The only specimens which I have found not to give good results by the method above given, are those from Tampa Bay, Florida, and the infusorial marls from Barbadoes. In the masses from Tampa the lapidification is so complete, that the alkali destroys the shells before the lumps break up; and in the case of the Barbadoes marls the cementing material is calcareous, and requires a dilute acid for its removal. In applying the above process one caution is necessary, which is to thoroughly wash the shells with *water*, and not with acids, as the latter will cause the deposit of a portion of the dissolved silica and materially injure the beauty of the specimens. When the washings are no longer alkaline, the specimens may then be thoroughly cleansed by acids or by the chlorate process described in the last number of this Journal. (See vol. xxi, p. 145.)

ART. XXXVI.—*On the non-existence of polarizing Silica in the Organic Kingdoms;* by Prof. J. W. BAILEY.

IT is now more than twenty years since Sir David Brewster announced the existence of polarizing or doubly refractive silica in the cuticle of Equisetum, and in that of some of the grasses. In Lindley's Natural System of Botany, the following account of Brewster's experiments is given. "On subjecting a portion of the cuticle of Equisetum hyemale to the analysis of polarized light under a high magnifying power, Brewster detected a beautiful arrangement of the siliceous particles, which are distributed in two lines parallel to the axis of the stem and extending over the whole surface. * * * Brewster also observed the remarkable fact that each particle has a regular axis of double refraction. In the straw and chaff of wheat, barley, oats and rye he noticed analogous phenomena." (Quoted by Lindley from Grevill. Fl. Edinens., 214.)

In Quekett's Treatise on the Microscope, 3d ed., p. 358, directions are given for preparing the siliceous cuticle of Equisetum hyemale for microscopic examination, by boiling in strong nitric acid, and it is added that "in balsam it forms a beautiful object for polarized light." Similar directions are given for preparing the silica in the chaff of wheat, oats, &c.

As these statements are contained in the last editions of each of the above-mentioned works, it is evident that no contradiction of the error involved in them has been pointed out; yet, notwithstanding the high authority on which they rest, the statements so far as the polarizing action of the silica is concerned are wholly erroneous. If the cuticle of the above-mentioned plants is completely deprived of its carbonaceous tissues it will be found wholly devoid of action on polarized light, and any preparation of the cuticle which is found to affect polarized light will also be found to blacken when heated in concentrated sulphuric acid, and if then decarbonised by throwing into the hot acid solution a little chlorate of potassa, the residual silica shows no signs of action under the polariscope, either alone or with the selenite plate, although it still retains the forms of the cells, stomata, &c.

It is clear then that the error in the above statements has been caused by the imperfect removal of the dense carbonaceous tissues which are deposited beneath the silica. I have examined several species of Equisetum and a large number of plants of the grass tribe which are most remarkable for their siliceous cuticles, but have found no trace of any action upon polarized light, when the carbonaceous matter was removed. But it is unnecessary to resort to artificial preparations to prove the correctness of my statements. Nature has made her own preparations, and deposited them by myriads beneath every peat bog, where may be found not only the siliceous shells of the Diatoms, and the spicules of the fresh-water sponges, but also a large number of the siliceous parts of the grasses, sedges, &c. Ehrenberg has shown, (Berlin Monthly Reports, May, 1848) and I can confirm his statements, that the silica in these Phytolitharia, as well as in the Diatomaceæ, Polycistineæ and Spongiolites is not doubly refractive. He makes an exception in the case of the shell of Arachnoidiscus, but my own experiments prove that when properly cleaned this shell forms no exception. As I have shown above that the silica in the cuticle of the Equisetum and grasses, agrees with that in the lower tribes in characters, I think the conclusion is warranted, that doubly refractive silica has no existence in the organic world.

ART. XXXVII.—*On the Pendulum experiments lately made in the Harton Colliery, for ascertaining the mean density of the Earth;* by G. B. AIRY, Esq., F. R. S., Astronomer Royal.*

THE speaker commenced with remarking that the bearing of the experiments, of which he was about to give a notice, was not limited to their ostensible object, but that it applied to all the bodies of the solar system. The professed object of the experiments was to obtain a measure of the density of the earth, and therefore of the mass of the earth (its dimensions being known); but the ordinary data of astronomy, taken in conjunction with the laws of gravitation, give the proportions of the mass of the earth to the masses of the sun and the principal planets; and thus the determination of the absolute mass of the earth would at once give determinations of the absolute masses of the sun and planets. To show how this proportion is ascertained, it is only necessary to remark, that a planet, if no force acted on it, would move in a straight line; that, therefore, if we compute geometrically how far the planet moves in a short time, as an hour, and then compute the distance between the point which the planet has reached in its curved orbit, and the straight line which it has left, we have found the displacement which is produced by the sun's attraction, and which is therefore a measure of the sun's attraction. In like manner, if we apply a similar calculation to the motion of a satellite during one hour, we have a measure of the attraction of its primary. The comparison of these two gives the proportion of the attraction of the sun, as acting upon a body, at one known distance, to the attraction of a planet, as acting upon a body at another known distance. It is then necessary to apply one of the theorems of the laws of gravitation, namely, that the attraction of every attracting body is inversely as the square of the distance of the attracted body; and thus we obtain the proportion of the attractions of the sun and a planet, when the bodies upon which they are respectively acting are at the same distance from both: and finally, it is necessary to apply another theorem of the law of gravitation, namely, that the attractions thus found, corresponding to equal distances of the attracted bodies, are in the same proportion as the masses of the attracting bodies (a theorem which applies to gravitation, but does not apply to magnetic and other forces). Into the evidence of these portions of the law of gravitation, the speaker did not attempt to enter: he remarked only that they rest upon very complicated chains of reasoning, but of the most certain kind. His only object was to show that the proportion of the masses of all bodies, which have planets or satellites re-

* Proc. Roy. Inst. of Great Britain, Part V, p. 17.

volving round them, can easily be found—(the proportion for those which have no satellites is found by a very indirect process, and with far less accuracy); and that if the absolute mass of the earth be known, the absolute mass of each of the others can be found. As their dimensions are known, their densities can then be found. Thus it rests upon such inquiries as those on which this discourse is to treat, to determine (for instance) whether the planet Jupiter is composed of materials as light as water, or as light as cork.

The obvious importance of these determinations had induced philosophers long since to attempt determinations of the earth's density: and two classes of experiments had been devised for it.

The first class (of which there was only one instance) is the attraction of a mountain, in the noble Schehallien experiment. It rests, in the first place, upon the use of the zenith sector; and, in the next place, upon our very approximate knowledge of the dimensions of the earth. [The construction of the zenith sector was illustrated by a model: and it was shown, that if the same star were observed at two places, the telescope would necessarily be pointed in the same direction at the two places, and the difference of direction of the plumb line, as shown by the different points of the graduated arc which it crossed at the two places, would show how much the direction of gravity at one place is inclined to the direction of gravity at the other place.] Now, from our knowledge of the form and dimensions of the earth, we know that the direction of gravity changes very nearly one second of angle for every hundred feet of horizontal distance. Suppose then, that two stations were taken on Schehallien, one on the north side and the other on the south side, and suppose that their distance was 4000 feet; then, if the direction of gravity had not been influenced by the mountain, the inclination of the directions of gravity at the two places would have been about 40 seconds. But suppose, on applying the zenith sector in the way just described, the inclination was found to be really 52 seconds. The difference, or 12 seconds, could only be explained by the attraction of the mountain, which, combined with what may be called the natural direction of gravity, produced directions inclined to these natural directions. In order to infer from this the density of the earth, a calculation was made (founded upon a very accurate measure of the mountain) of what would have been the disturbing effect of the mountain if the mountain had been as dense as the interior of the earth. It was found that the disturbance would have been about 27 seconds. But the disturbance was really found to be only 12 seconds. Consequently the proportion of the density of the mountain to the earth's density was that of 12 to 27, or 4 to 9 nearly. And from this, and the ascertained density of the mountain, it followed

that the mean specific gravity of the earth would be about five times that of water. The only objection to this admirable experiment is, that the form of the country near the mountain is very irregular, and it is difficult to say how much of the 12 seconds is or is not really due to Schehallien.

The second class is what may be called a cabinet experiment, possessing the advantage of being extremely manageable, and the disadvantage of being exceedingly delicate, and liable to derangement by forces so trifling that they could with difficulty be avoided. Two small balls upon a light horizontal rod were suspended by a wire, or two wires, forming a torsion balance, and two large leaden balls were brought near to attract the small balls from the quiescent position. We could make a calculation of how far the great balls would attract the little ones, if they were as dense as the general mass of the earth; and comparing this with the distance to which the leaden balls really do attract them, we find the proportion of the density of the earth to the density of lead. The peculiar difficulty and doubt of the results in this experiment depend on the liability to disturbances from other causes than the attraction of the leaden balls, especially the currents of air produced by the approach of bodies of a different temperature; and after all the cautions of Cavendish, Reich, and Bailey, in their successive attempts, it seems not impossible that the phenomena observed may have been produced in part by the temperature of the great balls as well as their attraction.

These considerations induced Mr. Airy, in 1826, to contemplate a third class of experiments, namely, the determination of the difference of gravity at the top and the bottom of a deep mine, by pendulum experiments. Supposing the difference of gravity found, its application to the determination of density (in the simplest case) was thus explained. Conceive a spheroid concentric with the external spheroid of the earth to pass through the lower station in the mine. It is easily shown that the attraction of the shell included between these produces no effect whatever at the lower station, but produces the same effect at the upper station as if all its matter were collected at the earth's centre. Therefore, at the lower station we have the attraction of the interior mass only: at the upper station we have the attraction of the interior mass (though at a greater distance from the attracted pendulum) and also the attraction of the shell. It is plain that by making the proportion of these theoretical attractions equal to the proportion actually observed by means of the pendulum, we have the requisite elements for finding the proportion of the shell's attraction to the internal mass's attraction, and therefore the proportion of the matter in the shell to the matter in the internal mass; from which the proportion of density is at once found. Moreover, it appeared probable, upon estimating the

errors to which observations are liable, that the resulting error in the density, in this form of experiment, would be less than in the others.

Accordingly, in 1826, the speaker, with the assistance of his friend Mr. Whewell (now Dr. Whewell), undertook a series of experiments at the depth of nearly 1200 feet, in the Dolcoath mine, near Camborne, in Cornwall. The comparison of the upper and lower clocks (to which further allusion will be made) was found to be the most serious difficulty. The personal labor was also very great. They had, however, made a certain progress when, on raising a part of the instruments, the straw packing took fire—(the origin of the fire is still unknown)—and partly by burning, and partly by falling, the instruments were nearly destroyed.

In 1828 the same party, with the assistance of Mr. Sheepshanks and other friends, repeated the experiment in the same place. After mastering several difficulties, they were stopped by a slip of the solid rock of the mine, which deranged the pumps and finally flooded the lower station.

The matter rested for nearly twenty-six years, the principal progress in the subjects related to it being the correction to the computation of "buoyancy" of the pendulum, determined by Colonel Sabine's experiments. But in the spring of 1854, the manipulation of galvanic signals had become familiar to the Astronomer Royal, and the assistants of the Greenwich Observatory, and it soon occurred to him that one of the most annoying difficulties in the former experiment might be considered as being practically overcome, inasmuch as the upper and lower clocks could be compared by simultaneous galvanic signals. Inquiries, made in the summer, induced him to fix on the Harton colliery near South Shields, where a reputed depth of 1260 feet could be obtained; and as soon as this selection was known, every possible facility and assistance were given by the owners of the mine. Arrangements were made for preparing an expedition on a scale sufficient to overcome all anticipated difficulties. A considerable part of the expense was met by a grant from the Board of Admiralty. The Electric Telegraph Company, with great liberality, contributed (unsolicited) the skill and labor required in the galvanic mountings. The principal instruments were lent by the Royal Society. Two observers were furnished by the Royal Observatory, one by the Durham Observatory, one by the Oxford Observatory, one by the Cambridge Observatory, and one by the private observatory of Red Hill (Mr. Carrington's). Mr. Dunkin, of the Royal Observatory, had the immediate superintendence of the observations.

The two stations selected were exactly in the same vertical, excellently walled, floored, and ceiled; the lower station in par-

ticular, was a most comfortable room or rather suite of rooms. Every care was taken for solidity of foundation and steadiness of temperature. In each (the upper and the lower) was mounted an invariable brass pendulum, vibrating by means of a steel knife edge upon plates of agate, carried by a very firm iron stand. Close behind it, upon an independent stand, was a clock, carrying upon the bob of its pendulum an illuminated disk, of diameter nearly equal to the breadth of the tail of the invariable pendulum; and between the two pendulums was a chink or opening of two plates of metal, which admitted of adjustment, and was opened very nearly to the same breadth as the disk. To view these a telescope was fixed in a wall, and the observer was seated in another room. When the invariable pendulum and the clock pendulum pass the central points of vibration at the same instant, the invariable pendulum hides the illuminated disk as it passes the chink, and it is not seen at all. At other times it is seen in passing the chink. The observation, then, of this disappearance determines a coincidence with great precision. Suppose the next coincidence occurs after 400 seconds. Then the invariable pendulum (swinging more slowly), has lost exactly two swings upon the clock pendulum, or the proportion of its swings to those of the clock pendulum is 398 : 400. If an error of a second has been committed, the proportion is only altered to 397 : 399, which differs by an almost insignificant quantity. Thus the observation, in itself extremely rude, gives results of very great accuracy. As the proportion of invariable-pendulum-swings to clock-pendulum-swings is thus found, and as the clock-pendulum-swings in any required time are counted by the clock dial, the corresponding number of invariable-pendulum-swings is at once found. Corrections are then required for the expansion of the metal (depending on the thermometer-reading), for the arc of vibration, and for the buoyancy in air (depending on the barometer-reading).

But when the corrected proportion of upper-invariable-pendulum-swings to upper-clock-pendulum-swings is found, and the proportion of lower-invariable-pendulum-swings to lower clock-pendulum-swings is found, there is yet another thing required:—namely, the proportion of upper-clock-pendulum-swings to lower-clock-pendulum-swings in the same time; or, in other words, the proportion of the clock rates. It was for this that the galvanic signals were required. A galvanometer was attached to each clock, and an apparatus was provided in a small auxiliary clock, which completed a circuit at every fifteen seconds nearly. The wire of this circuit, passing from a small battery through the auxiliary clock, then went through the upper galvanometer, then passed down the shaft of the mine to the lower galvanometer, and then returned to the battery. At each galvanometer there

was a small apparatus for breaking circuit. At times previously arranged, the circuit was completed by this apparatus at both stations, and then it was the duty of the observers at both stations to note the clock times of the same signals; and these evidently give comparisons of the clocks, and therefore give the means of comparing their rates. Thus (by steps previously explained), the number of swings made by the upper pendulum is compared with the number of swings made in the same time by the lower pendulum.

Still the result is not complete, because it may be influenced by the peculiarities of each pendulum. In order to overcome these, after pendulum A had been used above and pendulum B below, they were reversed; pendulum B being observed above and A below; and this, theoretically completes the operation. But in order to insure that the pendulum received no injury in the interchange, it is desirable again to repeat the experiments with A above and B below, and again with B above and A below.

In this manner the pendulums were observed with 104 hours of incessant observations, simultaneous at both stations, A above and B below; then with 104 hours, B above and A below; then with 60 hours, A above and B below; then with 60 hours, B adove and A below. And 2454 effective signals were observed at each station.

The result is, that the pendulums suffered no injury in their changes; and that the acceleration of the pendulum on being carried down 1260 feet is $2\frac{1}{4}$ seconds per day, or that gravity is increased by $-\frac{1}{15\,\frac{1}{5}\,5\,5}$ part.

It does not appear likely that this determination can be sensibly in error. The circumstances of experiment were, in all respects, extremely favorable; the only element of constant error seems to be that (in consequence of the advanced season of the year), the upper station was cooler by 7° than the lower station, and the temperature-reductions are therefore liable to any uncertainty which may remain on the correction for 7°. The reductions employed were those deduced by Sabine from direct experiment, and their uncertainty must be very small.

If a calculation of the earth's mean density were based upon the determination just given, using the simple theory to which allusion is made above, it would be found to be between six times and seven times the density of water. But it is necessary yet to take into account the deficiency of matter in the valley of the Tyne, in the hollow of Jarrow Slake, and on the seacoast. It is also necessary to obtain more precise determinations of the specific gravities of the rocks about Harton colliery than have yet been procured. Measures are in progress for supplying all these deficiencies. It seems probable that the resulting number for the earth's density will probably be diminished by these more accurate estimations.

Art. XXXVIII.—*On the rate of Evaporation on the Tulare Lakes of California;* By Wm. P. Blake, Washington, D. C.

Read before the National Institute, Washington, D. C., March 4th, 1856.

The Tulare plains of California wear a most desert-like and barren aspect during the summer and autumn. Treeless and without green vegetation, the surface becomes parched by the rays of an unclouded sun, and gives unobstructed passage to steady currents of air which pass inland from the ocean towards the Sierra Nevada. These winds, after passing the ranges of the Coast Mountains and becoming partially desiccated in their transit, impinge upon and traverse the plain, and reach the foot-hills of its eastern margin with a high temperature and apparently little moisture.

In the month of August, 1853, while with the U. S. Pacific R. R. survey, commanded by Lieut. R. S. Williamson, we encamped on the banks of Ocoya Creek, among the foot-hills of the Sierra, and every day felt the hot wind blowing inland toward the mountains. The parching effect produced by these winds, and the fact that after leaving the Coast Mountains they sweep over the broad and shallow Tulare lakes, induced me to desire to ascertain the rapidity of evaporation of water when fairly exposed to their action, and if possible to arrive at an approximate estimate of the amount of water removed daily from these lakes. For this purpose, I made the experiment of exposing water in a pan to the action of the wind, and noting the amount removed each day.

The valley of Ocoya Creek, in which our camp was located, has been formed by the erosion of the creek in a plateau of soft tertiary strata. It is thus bounded on each side by hills of horizontal stratification, and these were from 300 to 900 feet in height. They were perfectly barren and parched, and the only green vegetation visible was confined to the immediate banks of the creek. The altitude of the camp was 738 feet above mean-tide, and its distance from the open plain of the Tulares, two miles, from the lakes 25 miles, and from the sea in a direct east and west line 120 miles. The width of the valley was about one quarter of a mile, and its direction was nearly east and west, so that the breeze from the plain followed its course without deflection.

The wind usually blew gently from the mountains during the night and early in the morning, but after the sun had risen, and about 10 o'clock its direction was reversed and it blew steadily and often strongly from the west or northwest until sunset, when it generally ceased.

The experiment was conducted in the following manner. A large sheet-iron pan, such as is used by the miners for "prospecting," and which corresponds very nearly in size and shape with an ordinary milk-pan, was placed upon a firm stand about two feet above the surface of the ground. This pan was nearly filled with water and a thermometer and small ivory scale were immersed in it. The whole was in a situation favorably exposed to the action of the winds, and was protected from the direct rays of the sun by a shed, covered with brush and leaves. The shade preventing the sun from unduly heating the water by acting on the bottom and sides of the pan. The amount of evaporation was noted from time to time by the height of the water on the scale. The results are given in the annexed table.

Table showing daily evaporation at Posé Creek, Cal.

Date.	Time.	Ther. air.	Ther. water.	Quantity evapor'd.	Daily evap n.	Remarks—winds, &c.
1853.				Inches.		
Aug. 26	sunrise	65°	62°			
	12 M.					
	2 P. M.	100°	80°	$\frac{2}{16}$		
	6 "		78°	$\frac{2}{16}$	$\frac{4}{16}$	Wind NW and steady from 11 A. M. till sunset.
" 27	sunrise	60°	58°			
	9 A. M.	85°	70°	$\frac{1}{16}$		Wind rising and from the SW.
	12 M.	96°	78°			
	2 P. M.	100°	82°	$\frac{1}{16}$		Wind strong and from NW.
	4 "	100°	80°	$\frac{2}{16}$		
	5·30 "	96°	78°	$\frac{1}{16}$	$\frac{5}{16}$	
" 28	6 A. M.	60°	56°			
	12·30	95°	78°	$\frac{2}{16}$		Wind strong since 11 A. M.
	4·30P M.			$\frac{1}{16}$		
	6 P. M.			$\frac{1}{16}$	$\frac{4}{16}$	Wind ceased at 6.
" 29	6 A. M.	52°	50°			
	12·30PM	86°	74°	$\frac{1}{16}$		Wind rising at 9 A. M.
	4 P. M.	90°	75°	$\frac{2}{16}$	$\frac{3}{16}$	

From this table it will be seen that the observations were continued for four days, and that the mean daily evaporation was *one quarter of an inch.* This was shown not only by the sum of the daily or hourly results, but by the total loss in the four days as indicated on the scale at the close of the experiment. This result was below my anticipations, and yet when the depth of evaporation is multiplied by the superficial area, the quantity appears enormous. The rapidity of the evaporation was doubtless retarded by impurities in the water, which was taken from the creek and soon deposited a slight sediment, and on the third day was covered with a thin film or pellicle, probably of light dust, which must have offered great protection from the action of the air.

It will be observed that the evaporation ceased at night. The temperature of the air was always rapidly reduced after sunset, but there was no dew. As these low, night temperatures did not influence the result, we may take the mean of the day temperatures both for the air and the water at the time of observation,—subject to the slight error caused by the deficiency of observations on the 26th and 28th—and obtain approximately the temperature conditions of the air and water for that amount of evaporation. These results are, for the air 83°·9, for the water 71°·5; time, 46 hours. Height of barometer 29·30.

Although at the time of these experiments I regarded the air as exceeding dry, I have since been forced to the conclusion that its condition was not the most favorable to great and rapid absorption of water. The crests of the ranges of the Coast Mountains are not greatly elevated in that region—being, probably, less than 4000 feet—and during the day they are much heated by the sun: they do not, therefore, cause the precipitation of all the moisture which the air brings with it from the sea, and its thorough desiccation is not accomplished. A great part of its moisture is necessarily retained, and a capacity for the absorption of more is given by the elevation of temperature which it suffers among the interior ranges and valleys of the coast, and finally upon the broad and heated plain. It is well to consider these conditions in connexion with the experimental results, and if the air is thus highly charged with moisture, the quantity taken up must be regarded as very large. At the rate of one quarter of an inch a day, seven inches and a half in depth will be removed in thirty days, or seven feet seven and a quarter inches in one year. According to Dr. G. Buist, the amount of evaporation from the surface of water at Aden, on the Indian Ocean, "is about eight feet for the year."* The bases of this statement is not given, but it is interesting to notice that the amount agrees with my experimental result.

The facts which have been given, derive importance and interest from the bearing they have upon the phenomena of the evaporation from the surface of the Tulare lakes. These lakes are broad, shallow sheets of water, with shelving marshy shores, without bluffs or terraces. They occupy the lowest parts of the Tulare valley and receive the drainage of the broad western slope of the Sierra Nevada for the whole distance south of the San Joaquin, a distance, if measured along the summit of the mountains, of nearly 200 miles. Among the streams which empty into them, are three of considerable magnitude, Kern river, King's river, and the Caweea or Four creeks. The flow in these streams is constant through the year, and they are often very much swollen by the melting of the distant snows, even

* Trans. Bombay Geographical Society, vol. ix, 1849–50, p. 39.

late in the summer. Although the lakes have no outlet, and they are daily receiving this immense supply of water, their level is not raised, but on the contrary the borders give evidence that they are gradually drying up. We must conclude from these facts that the evaporation from the lakes is equal to, if not greater than the supply.

If we regard the experimental result as a fair measure of the evaporation from the lakes, we may readily calculate the amount of water taken from them during a month or year. We have 36 cubic inches of water for the daily evaporation from one square foot of surface and consequently 522929·5 cubic feet from every square mile. This equals 16210·8 tons or 4,052,703 gallons—a quantity of which we can scarcely form an adequate conception, and yet it is for one day only. If we measure the amount of evaporation in depth, and assume that the quantity evaporated is equal during each month in the year, we have as before observed, seven feet seven inches and one quarter for the yearly evaporation. The conditions which I have detailed, do not, however, exist throughout the year. In the rainy months, the evaporation is much reduced or perhaps it almost ceases. It is almost certain however that the experiment does not show the full amount of evaporation for the summer; it is undoubtedly much greater, and the results can only be regarded as approximate. They are however important, and derive greater interest from the fact that few experiments of the kind have been made, and because the climatic conditions of that region are so peculiar.

Art. XXXIX.—*On Electric Conduction;* by Professor Faraday, D.C.L., F.R.S.*

Since the time when the law of definite electrolytic action was first laid down (*Exp. Res.* 783–966), it has become a question whether those bodies which form the class of electrolytes, conduct only whilst they are undergoing their proper change under the action of the electric current; or whether they can conduct also as metals, dry wood, spermaceti, &c., do in different degrees, *i. e.* without the accompaniment of any chemical change within them. The first kind of conduction is distinguished as the *electrolytic;* the transference of the electric force appearing to be essentially associated with the chemical changes which occur; the second kind may be called *conduction proper;* and there the act of conduction leaves the body ultimately as it found it. Electrolytic conduction is closely associated with the liquid state, and with the compound nature and chemical proportions of

* Proc. Roy. Inst. of Great Britain, Part V, p. 123.

the bodies in which it occurs; and it is considered as varying in degree (*i. e.* in facility) with the affinities of the constituents belonging to these bodies; there are, however, other circumstances which evidently, and indeed very strongly, affect the readiness of transfer, such as temperature, the presence of extraneous matters, &c. Conduction proper differs as to facility by degrees so far apart, that the quantity of electricity which could pass through a hundred miles of one substance, as copper, in an inappreciably small portion of time, would require ages to be transmitted through the like length of another substance, as shell-lac; and yet the copper with its similars offers resistance to conduction; and the lac, and its congeners, conduct.

The progress and necessities of science have rendered it important within the last three or four years, and especially at the present moment, that the question "whether an electrolyte has any degree of conduction proper" should be closely considered, and the experiments which are fitted to probe the question have been carried to a very high degree of refinement. Buff,* by employing the electric machine, and Wollaston terminals, i. e. platinum wires sealed into glass tubes, and having the ends only exposed, has decomposed water by a quantity of electricity so small that it required four hours to collect gas enough to fill a little cylinder only one-tenth of an inch in diameter, and the one-fifth of an inch in length; yet the decomposition was electrolytic and polar; and therefore the conduction was electrolytic also. When one pole only was in the water, and the other in the air over it, still the decomposition, and therefore the conduction, was electrolytic; for one element appeared at the pole in the water, and the other in the air or gas over the water at the corresponding pole. Buff concludes that electrolytes have no conduction proper. Many other philosophers have supported, with more or less conviction, the same view, and believe that electrolytic conduction extends to, and includes cases, which formerly were supposed to depend upon conduction proper. Soret advances certain experimental results,† but reserves his opinion from being absolute. Von Breda and Logeman adopt the more general view unreservedly.‡ De la Rive, I think, admits that a very little may perhaps pass by conduction proper, but that electrolytic conduction is the function of electrolytes.§ Matteucci has at one time admitted a little conduction proper, but at present, I believe, denies that any degree exists. On the other hand, Despretz,‖ Leon Foucault,¶ Masson,** and myself, have always admitted the possibility that electrolytes possess a certain amount

* MS. letter. † Annales de Chimie, xlii, 257. ‡ Phil. Mag., viii, 465.
§ Bibl. de Genève, xxvi, 134, 144; xxvii, 177. ‖ Comp. Rend., xxxviii, 897.
¶ Comp. Rend., xxxvii, 580; or Bibl. de Genève, xxiv, 263; xxv, 180; xxvi, 126.
** Prize Essay, Haarlem Trans., xi, 78.

of conduction proper—small indeed, but not so small as to prevent its being evident in certain forms of experiments: and beautiful and close as the electrolytic proofs have been carried, they are not by us considered as sufficient to show that the function of conduction proper is altogether absent from electrolytes.

(Some account was then given of the experiments and arguments on both sides; and of the striking electrolytic fact, that if a current of electricity, however small, is sent through a circuit containing a couple of platina plates in dilute sulphuric acid, the plates are found thereby electrically polarized.)

The inquiry as regards electrolytes takes on three forms. They may possess a degree of conduction proper at all times—or they may be absolutely destitute of conduction proper—or they may possess conduction proper up to a certain condition, governed either by requisite intensity for electrolyzation or by other circumstances, but which, when that condition is acquired, changes into electrolytic conduction; and these three forms may be further varied by considerations dependent upon the physical state of the electrolyte, as whether it be solid or liquid, hot or cold, and whether it be pure or contain other substances mingled with it.

From the time when the question was raised by myself, twenty years ago, to the present day, I have found it necessary to suspend my conclusions; for close as the facts have in certain cases been urged by those who believe they have always obtained decomposition results, when an electrolyte has performed the part of a conductor, and freely as I could have admitted the facts and the conclusions if there had been no opposing considerations, still, because there are such considerations, I am obliged to reserve my judgment. In the first place all bodies not electrolytic, even up to gases (Becquerel,) are admitted to possess conduction proper; *a priori*, therefore, we have reason to expect that electrolytes will possess it also. If from amongst different bodies we retain for consideration the class of electrolytes only, then though the amount of electricity of a given intensity which these can transmit electrolytically when they are *fluid*, is often almost infinitely greater than that which they can convey onwards by conduction proper, when they are *solid*; still the conduction in the latter cases is very evident. A piece of perfectly dry solid nitre, and of many other electrolytes, discharges a gold leaf electrometer very freely, and I believe by the power of conduction proper; and that being the case, I do not see that the assumption of the very highest condition of electrolytic conduction when the nitre is rendered fluid is any argument for the absolute disappearance of the conduction proper which belonged to the body in the solid state, though it may override the latter for the time and make it insensible. These considerations are, however, such as

arise rather from the absence of the final and strict proof on the opposite side, than from anything very positive in their own character; but it has occurred to me that the phenomena of static electricity will furnish us with many reasons of a positive nature, in favor of the possession by liquid electrolytes of the power of conduction proper. Some of these I will endeavor briefly to state, illustrating the subject by a reference to water, which in its pure state has but a low degree of electrolytic conduction.

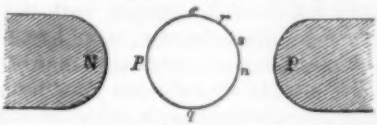
The ordinary phenomena of static charge and induction are well known. If an excited glass rod or other body be held near a light gilt sphere, suspended from the hand by a metal thread, the inductive action disturbs the disposition of the electricity in the sphere, and the latter is strongly attracted: if in place of the sphere a soap bubble be employed, the same results occur. If a dish filled with pure distilled water be connected with the earth by a piece of moist bibulous paper, and a ball of excited shell-lac be suspended two or three inches above the middle of the water, —and if a plate of dry insulating gutta-percha, about eight inches long and two inches wide, have its end interposed between the water and the shell-lac, it may then be withdrawn and examined, and will be found without charge, even though it may have touched the shell-lac; but if the end once touch the water under the lac (and it may be dipped in,) so as to bring away a film of it, charged with the electricity the water has acquired by the induction, it will be found to possess, as might be expected, a state contrary to that of the inductric shell-lac.

In order to exclude any conducting body but water from what may be considered as a reference experiment, two calico globular bags with close seams were prepared; and being wetted thoroughly with distilled water, were then filled with air by means of a fine blow-pipe point; they were then attached to two suspending bands of gutta-percha, by which they were well insulated, and being three inches in diameter, they formed, when placed in contact, a double system six inches in length. A metallic ball, about four inches in diameter, was connected with the electric machine to form an inductric body, an uninsulated brass plate was placed about nine inches off to form an inducteous body; between these, the associated water balls could be placed so as to take part in the induction, and when the electric charge was so low that the moist atmosphere caused no transmission of electricity, the balls could be introduced into position and brought away without having received any permanent charge. Under these circumstances if the associated balls were brought into the place of induction, were then separated, withdrawn, and examined, they were found, the one charged positively and the other negatively, by electricity derived from themselves, and without

conductive or convective communication with any other substance than their own water.

It is well known indeed that by the use of water we may replace metal in all electro-static arrangements, and so form Leyden jars, condensers, and other induction apparatus, which are perfect in principle though with imperfect action. The principles are the same, whether water or metals be used for conductors, and the function of conduction is essential to all the results; therefore conduction cannot be denied to the fluid water, which in all such cases is acting as the only conductor. In nature, indeed, the phenomena of induction, rising up to their most intense degree in the thunder-storm, are almost, if not altogether, dependent upon the water which in the earth, or the clouds, or the rain, is then acting by its conducting power; and if this conducting power be of the nature of *conduction proper*, it is probable that that function is as large and as important as any exercise of the electrolytic conduction of water in other natural phenomena.

But it may be said that all these cases, when accompanied by conduction, involve a corresponding and proportionate electrolytic effect, and are therefore cases of electrolytic conduction; and it is the following out of such a thought that makes me think the results prove a conduction proper to exist in the water. For suppose a water bubble to be placed midway between a positive and a negative surface, as in the figure, then the parts at and about p will become charged positive, and those at and about n negative, solely by the disturbance of the electric force originally in the bubble, i. e. without any direct transmission of the electric force from N or P; the parts at e or q will have no electric charge, and from those parts to p and n the charge will rise gradually to a maximum. The electricity which appears at p, n, and elsewhere, will have been *conducted* to these parts from other parts of the bubble; and if the bubble be replaced by two hemispheres of metal, slightly separated at the equatorial parts e, q, the electricity (before *conducted* in the continuous bubble,) will then be seen to pass as a bright spark. Now the particles at any part of the water bubble may be considered under two points of view, either as having had a current passed through them, or as having received a charge; in either view the idea of conduction proper supplies sufficient and satisfactory reasons for the results; but the idea of electrolytic conduction seems to me at present beset with difficulties. For consider the particles about the equator e q, they acquire no final charge, and they *have conducted*, as the action of the two half spheres above referred to show; and they are not in a state of mutual tension, as is fully proved by very simple



experiments with the half hemispheres. Therefore oxygen must have passed from *e* towards *n*, hydrogen from *e* towards *p*, i. e. towards and to the parts to which the electricity has been conducted, for without such transmission of the anions and cations there would be no transmission of the electricity, and so no electrolytic conduction. But then the questions arise,—where do these elements appear? is the water at *n* oxygenated, and that about *p* hydrogenated? and may the elements be at last dispersed into the air at these two points, as in the case of decompositions against air poles? (*Exp. Res.* 455, 461, &c.) In regard to such questions other considerations occur respecting the particles about *p* and *n*, and the condition of charge they have acquired. These have received the electricity which has passed as a current through the equatorial parts, but they have had no current or no proportional current through themselves—the conduction has extended *to* them but not *through* them; no electricity has passed for instance through the particle at *n* or at *p*, yet more electricity has gone by some kind of conduction to them than to any other of the particles in the sphere. It is not consistent with our understanding of electrolytic conduction to suppose that these particles have been charged by such conduction; for in the exercise of that function it is just as essential that the electricity should *leave* the decomposing particle on the one side, as that it should *go to it* on the other: the mere escape of oxygen and hydrogen into the air is not enough to account for the result, for such escape may be freely permitted in the case of electrodes plunged into water; and yet if the electricity cannot pass from the decomposing particles into the electrodes, and so away by the wires, in a condition enabling it to perform its full equivalent of electric work anywhere else in the circuit, there is no decomposition at the final particles of the electrolyte, nor any electrolytic conduction in its mass. Even in the air cases above referred to there is a complete transmission of the electricity across the extreme particles concerned in the electrolysis.

If the above reasoning involve no error, but be considered sufficient to show that the particles at *p* and *n* are not electrolyzed, then it is also sufficient to prove that none of the particles between *p* and *n* have been electrolyzed; for though one at *e* or *q* may have had a current of electricity passed through it, it could not give up its elements unless the neighboring particles were prepared to take them in a fully equivalent degree. To stop the electrolysis at *n* and *p*, or at those parts of the surface where the moving electricity stops, is to stop it at all the intervening parts according to our present views of electrolysis, and to stop the electrolysis is to shut out electrolytic conduction; and nothing at present remains but *conduction proper*, to account for the very manifest effects of conduction which occur in the case.

It may be imagined that a certain polarized state of tension occurs in these cases in static induction, which is intermediate between it and electrolytic conduction (*Exp. Res.* 1164); or that a certain preparatory and as it were incomplete condition may be assumed, distinguishing the case of static conduction with globes of water, which I have taken as the ground of consideration from the same case when presented by globes of metal. Our further and future knowledge may show some such state; but in respect of our present distinctive views of conduction proper and electrolytic conduction, it may be remarked that such discovery is just as likely to coincide with the former as with the latter view, though it most probably would alter and correct both.

Falling back upon the consideration of the particles between *e* and *n*, we find, that whether we consider them as respects the current which has passed through them, or the charge which they have taken, they form a continuous series; the particle at *e* has had most current, that at *n* none, that at *r* a moderate current; and there are particles which must have transmitted every intermediate degree. So with regard to charge; it is highest at *n*, nothing at *e*, and every intermediate degree occurs between the two. Then with respect to these superficial particles, they hold all the charge that exists, and therefore all the electricity which has been conducted is in them; consequently all the electrolytic results must be there; and that would be the case, even though for the shell we were to substitute a sphere of water. For, if those particles which have had more current through them than others be supposed to have more of the electrolytic results about them than the others, then that electricity which is found associated chiefly, if not altogether, with these others, could have reached them only by conduction proper, which for the moment is assumed to be non-existent. So, to favor the electrolytic argument, we will consider the conduction as ending at, and the electrolytic results as summed up in, these superficial particles, passing for the present the former objection that though the electricity has reached, it has not gone through, these particles. Taking, therefore, a particle at *r*, and considering its electrolytic condition as proportionate to the electricity which has arrived at that particle, and given it charge, we may then assume, for we have the power of diminishing the inductive action in any degree, that the electricity, the conduction of which has ceased upon the particle that was there has been just enough to decompose it, and has left what was the under but is now the surface particle, charged. In that case, some other particle, in a higher state of charge, and nearer to *n*, as at *s*, will have had enough electricity conducted towards its place to decompose two particles of water;—but it is manifest that this cannot be the

next particle to that at *r*, but that a great number of other particles in intermediate states of charge must exist between *r* and *s*. Now the question is, how can these particles become intermediately charged by virtue of electrolytic conduction only? Electrolytic action is definite, and the very theory of electrolytic conduction assumes that the particles of oxygen and hydrogen as they travel convey not a variable but a perfectly definite amount of power onward in its course, which amount they cannot divide, but must take at once from a like particle, and give at once to another like particle. How then can any number of particles, or any action of such particles carry a fraction of the force associated with each particle? It is no doubt true, that if two charged particles can throw their power either on to one, or to three or more other particles, then all the difficulty disappears. Conduction proper can do this: but, as we cannot conceive of a particle half decomposed, so I cannot see how this can be performed by electrolytic conduction, i. e. how the particle between *r* and *s* can be excited to the intermediate and indefinite degree, conduction without electrolysis being denied both to it and the particles around it.

If the particles between *e* and *n* be supposed to conduct electrolytically by the current which passes *through* them (dismissing for a time, amongst other serious objections, that already given that the products would not be found at the places to which the electricity has been conveyed) still the present argument would have like force. At *r* enough electricity may have passed through to decompose two particles of water, at *s* only enough to decompose one,—how is a particle between *r* and *s* to change elements with the particles either towards *r* or towards *s*, if electrolytic change only is to be admitted? or how, as before inquired, can two particles throw their power on to, or receive their power from one? Many other considerations spring out of the thought of a water bubble, under static induction; but these just expressed, with those that relate to the *seat* of electrolytic action, whether at the place of current or of charge, create a sum of difficulty fully sufficient, without any others, to make me suspend for the present any conclusions on the matter in question.

The conduction power of water may be considered under another point of view; namely, that which has relation to the absolute charge that can be given to the fluid. A point from the electrical machine can charge neighboring particles of air, and they issue off in streams. It can do the same to particles of camphene, or oil of turpentine;—it can do the same to the particles of water; and if two fine metallic wires connected with Ruhmkorff's apparatus, be immersed in distilled water, about half an inch apart, the motes usually present will soon show how the water receives charge, and how the charged water passes off

in streams, which discharge to each other in the mass. Now such charge is not connected with electrolysis; the condition of electrolyzation is that the electricity pass through the water and do not stop short in it. The mere charge of the water give us no idea where any constituents set loose by electrolysis can be evolved, and yet conduction is largely concerned in the act of charging. A shower of rain falls across a space in the atmosphere subject to electric action, and each drop becomes charged; spray may be thrown forth from an electrified fountain very highly charged;—conduction has been eminently active in both cases, but I find it very difficult to conceive how that conduction can be electrolytic in its character.

When drops of water, oppositely electrified, are made to approach each other, they act by convection, i. e. as carriers of electricity; when they meet they discharge to each other, and the function of conduction is for the time set up. When the water bubble, described p. 372, is taken out of the sphere of induction, the opposite electricities about p and n neutralize each other, being conducted through the particles of the water. Are we to suppose in these cases that the conduction is electrolytic? if so, where are the constituents separated, and where are they to appear? It must be a strong conviction that would deny conduction proper to electrolytes in these cases; and if not denied here, what reason is there ever to deny it absolutely.

The result of all the thought I can give to the subject is a suspended judgment. I cannot say that I think conduction proper is as yet disproved in electrolytes; and yet I cannot say that I know of any case in which a current, however weak, being passed by platinum electrodes across acidulated water does not bring them into a polarized condition. It may be that when metallic surfaces are present, they complete by their peculiarities the condition necessary to the evolution of elements, which, under the same degree of electrification would not be evolved if the metals were away; and, on the other hand, it also may be that after the metals are polarized, and a consequent state of reactive tension so set up, a degree of conduction proper may occur between them and the electrolyte simultaneously with the electrolytic action. There is now no doubt that as regards electrolysis and its law, all is as if there were but electrolytic conduction; but, as regards static phenomena (which are equally important) and the steps of their passage into dynamic effects, it is probable that conduction proper rules with electrolytes as with other compound bodies: for it is not as yet disproved, is supported by strong presumptive evidence, and may be essential. Yet so distant are the extremes of electric intensity, and so infinitely different in an inverse direction are the quantities that may and do produce the essential phenomena of each kind, that

this separation of conductive action may well seem perfect and entire to those whose minds are inclined rather to see conduction proper replaced by electrolytic conduction, than to consider it as reduced, but not destroyed; disappearing, as it were, for electricity of great quantity and small intensity, but still abundantly sufficient for all natural and artificial phenomena, such as those described, where intensity and time both unite in favoring the final results required.

But we must not dogmatise on natural principles, or decide upon their physical nature without proof; and, indeed, the two modes of electric action, the electrolytic and the static, are so different yet each so important, the one doing all by quantity at very low intensity, the other giving many of its chief results by intensity with scarcely any proportionate quantity, that it would be dangerous to deny too hastily the conduction proper to a few cases in static induction, where water is the conductor, whilst it is known to be essential to the many, only because, when water is the electrolyte employed, electrolytic conduction is essential to every case of electrolytic action.

ART. XL.—*On the Occurrence of numerous Fragments of Fir-wood in the Islands of the Arctic Archipelago; with Remarks on the Rock Specimens brought from that Region;* by Sir RODERICK IMPEY MURCHISON, D.C.L., F.R.S., V.P.G.S., Director-General of the Geological Survey.*

ON the present occasion I cannot attempt to offer any general, still less any detailed description of the rocks and fossils of the northwestern portion of that great Arctic Archipelago whose shores were first explored by Parry and Sabine. The specimens they brought home from Melville Island, and which were described by Mr. König, first conveyed to us the general knowledge of the existence there of fossiliferous limestones and other rocks analogous to known European types in Scandinavia. Since those early days, the voyages of Franklin, and of the various gallant officers who have been in search of our lamented friend, have amplified those views, and have shown us that over nearly the whole of the Arctic Archipelago these vast islands possess a structure similar to that of North America. We shall soon, I believe, be made acquainted with the characters of the specimens collected by the expedition under Sir Edward Belcher, who is preparing a description of the natural-history products of his survey. My chief object now is to call attention to the remarkable fact of the occurrence of considerable quantities of wood, capable

* From the Quarterly Journal of the Geological Society of London, vol. xi, p. 36.

of being used for fuel or other purposes, which exist in the interior, and on the high grounds of large islands in latitudes where the dwarf willow is now the only living shrub.

Before I allude to this phenomenon, as brought to my notice by Capt. M'Clure and Lieut. Pim, I would, however, briefly advert to a few rock specimens collected by the latter officer in Beechey Island, Bathurst Land, Eglinton Island, Melville Island, Prince Patrick's Island, and Banks's Land, where he joined Capt. M'Clure,—specimens which we ought to value highly, seeing that they were saved from loss under very trying circumstances.

From this collection, as well as from other sources to which I have had access, as derived from the voyages of Parry, Franklin, Back, Penny, Inglefield, and the recent work of Dr. T. Sutherland, I am led to believe that the oldest fossiliferous rock of the Arctic region is the upper Silurian, viz., a limestone identical in composition and organic contents with the well-known rocks of Wenlock, Dudley, and Gothland.

No clear evidence has been offered as to the existence of Devonian rocks, though we have heard of red and brownish sandstone, as observed in very many localities by various explorers, and which possibly may belong to that formation. Thus, in North Somerset, to the south of Barrow Straits, red sandstone is associated with the older limestone. Byam Martin Island was described by Parry as essentially composed of sandstone, with some granitic and feldspathic rocks; and, whilst the northeastern face of Banks's Land is sandstone, its northwestern cliffs consist (as made known by Capt. M'Clure) of limestone. But whilst in the fossils we have keys to the age of the Silurian rocks, we have as yet no adequate grounds whereon to form a rational conjecture as to the presence of the Old Red Sandstone, or Devonian group.

True Carboniferous *Producti* and *Spiriferi* have been brought home by Sir E. Belcher from Albert Land, north of Wellington Channel; and hence we may affirm positively, that the true Carboniferous rocks are also present. Here and there bituminous schist and coal are met with; the existence of the latter being marked at several points on the general chart published by the Admiralty. With palæozoic rocks are associated others of igneous origin and of crystalline and metamorphosed character. Thus, from Eglinton Island to the south of Prince Patrick's Island, first defined by the survey of Capt. Kellet and his officers, we see concretions of greenstone, associated with siliceous or quartzose rocks and coarse ferruginous grits; and in Princess Royal Island, besides the characteristic Silurian limestones, there are black basalts and red jaspers, as well as red rocks, less altered by heat, but showing a passage into jasper. Highly crystalline gypsum was also procured by Lieut. Pim from the northwestern shores of Melville Island. In the collection before us we see silicified

stems of plants, which Lieut. Pim gathered on various points between Wellington Channel on the east and Banks's Land on the west. Similar silicified plants were also brought home by Capt. M'Clure from Banks's Land; and, through the kindness of Mr. Barrow, to whom they were presented, they are now exhibited, together with a collection made by Capt. Kellet, which he sent to Dr. J. E. Gray of the British Museum, who has obligingly lent them for comparison.

I had requested Dr. Hooker to examine all those specimens which passed through my hands, and I learn from him that he will prepare a description of them, as well as of a great number from the same region, which had been sent to his father, Sir W. Hooker, associated, like those now under consideration, with fragments of recent wood.

Of secondary formations no other evidence has been met with except some fossil bones of Saurians, brought home by Sir E. Belcher, from the smaller islands north of Wellington Channel; and of these fossils Sir Edward will give a description. Of the old Tertiary rocks, as characterized by their organic remains, no distinct traces have, as far as I am aware, been discovered; and hence we may infer that the ancient submarine sediments, having been elevated, remained during a very long period beyond the influence of depository action.

Let us now see how the other facts, brought to our notice by the gallant Arctic explorers who have recently returned to our country, bear upon the relations of land and water in this Arctic region during the quasi-modern period, when the present species of trees were in existence.

Capt. M'Clure states that in Banks's Land, in latitude 74° 48′, and thence extending along a range of hills varying from 350 to 500 feet above the sea, and from half a mile to upwards inland, he found great quantities of wood, some of which was rotten and decomposed, but much of it sufficiently fresh to be cut up and used as fuel. Whenever this wood was in a well-preserved state, it was either detected in gullies or ravines, or had probably been recently exhumed from the frozen soil or ice. In such cases, and particularly on the northern faces of the slopes where the sun never acts, wood might be preserved any length of time, inasmuch as Capt. M'Clure tells me he has eaten beef, which, though hung up in his cold larder for two years, was perfectly untainted.

The most remarkable of these specimens of well-preserved recent wood is the segment of a tree, which, by Capt. M'Clure's orders, was sawn from a trunk sticking out of a ravine, and which is now exhibited.* It measures 3 feet 6 inches in circumference.

* Through the kindness of Mr. John Barrow, to whom it had been given, this wood, with some silicified stems, has been presented to the Museum of Practical Geology.

Still more interesting is the cone of one of these fir-trees which he brought home, and which apparently belongs to an *Abies* resembling *A. alba*, a plant still living within the Arctic circle. One of Lieut. Pim's specimens of wood from Prince Patrick's Island is of the same character as that just mentioned, and in its microscopical characters much resembles *Pinus strobus*, the American Pine, according to Prof. Quekett, who refers another specimen, brought from Hecla and Gripper Bay, to the *Larch*.

In like manner Lieut. Pim detected similar fragments of wood two degrees farther to the north, in Prince Patrick's Land, and also in ravines of the interior of that island, where, as he informed me, a fragment was found like the tree described by M'Clure, sticking out of the soil on the side of a gully.

We learn, indeed, from Parry's 'Voyage,' that portions of a large fir-tree were found at some distance from the south shore of Melville Island, at about 30 feet above high-water mark, in latitude 74° 59′ and longitude 106°.* According to the testimony of Capt. M'Clure and Lieut. Pim, all the timber they saw resembled the present drift-wood so well known to Arctic explorers, being irregularly distributed, and in a fragmentary condition, as if it had been broken up and floated to its present positions by water. If such were the method by which the timber was distributed, geologists can readily account for its present position in the interior of the Arctic Islands. They infer that at the period of such distribution large portions of these tracts were beneath the waters, and that the trees and cones were drifted from the nearest lands on which they grew. A subsequent elevation, by which these islands assumed their present configuration, would really be in perfect harmony with those great changes of relative level which we know to have occurred in the British Isles, Germany, Scandinavia, and Russia since the great glacial period. The transportation of immense quantities of timber towards the North Pole, and its deposit on submarine rocks, is by no means so remarkable a phenomenon as the wide distribution of erratic blocks during the glacial epoch over Northern Germany, Central Russia, and large portions of our island when under water, followed by the rise of these vast masses into land. If we adopt this explanation, and look to the extreme cold of the Arctic region in the comparatively modern period during which this wood has been drifted or preserved, we can have no difficulty in accounting for the different states in which the timber is found. Those portions of it which happened to have been exposed to the alter-

* "Serjeant Martin of the Artillery and Capt. Sabine's servant brought down to the beach several pieces of a large fir-tree, which they found nearly buried in the sand at the distance of 300 or 400 yards from the present high-water mark, and not less than 30 feet above the level of the sea."—Parry's Voyage for the Discovery of the Northwest passage, p. 68.

nations of frost and thaw, and the influence of the sun, have necessarily become rotten; whilst all those fragments which remained enclosed in frozen mud or ice which have never been melted, would, when brought to light by the opening of ravines or other accidental causes, present just as fresh an appearance as the specimens now exhibited.

The only circumstance within my knowledge which militates against this view is one communicated to me by Capt. Sir Edward Belcher, who in lat. 75° 30′, long. 92° 15′, observed on the east side of Wellington Channel the trunk of a fir-tree standing vertically, and which, being cleared of the surrounding earth, &c., was found to extend its roots into what he supposed to be the soil.

If from this observation we should be led to imagine that all the innumerable fragments of timber found in these polar latitudes belonged to trees that grew upon the spot, and on the ground over which they are now distributed, we should be driven to adopt the anomalous hypothesis, that, notwithstanding physical relations of land and water similar to those which now prevail (*i. e.* of great masses of land high above the sea), trees of large size grew on such *terra firma* within a few degrees of the North Pole!—a supposition which I consider to be wholly incompatible with the data in our possession, and at variance with the laws of isothermal lines.

If, however, we adopt the theory of a former submarine drift,* followed by a subsequent elevation of the sea-bottom, as easily accounting for all the phenomena, we may explain the curious case brought to our notice by Sir Edward Belcher, by supposing that the tree he uncovered had been floated away with its roots downwards, accompanied by attached and entangled mud and stones, and lodged in a bay, like certain "snags" of the great American rivers. Under this view, the case referred to must be considered as a mere exception, whilst the general inference we naturally draw is, that the vast quantities of broken recent timber, as observed by numerous Arctic explorers, were drifted to their present position when the islands of the Arctic Archipelago were submerged. This inference is indeed supported by the unanswerable evidence of the submarine associates of the timber: for, from the summit of Coxcomb Range in Banks's Land, and at a height of 500 feet above the sea, Capt. M'Clure brought home a fine large specimen of *Cyprina Islandica*, which is undistinguishable from the species so common in the glacial drift of the

* Dr. Hooker informs me that all the specimens sent to him were collected in mounds of silt, rising up from the level of the sea to 100 feet or more above it; and he entirely coincides with me in the belief that the whole of this timber was drifted to the spots where it now lies.

Clyde;* whilst Capt. Sir E. Belcher found the remains of whales on lands of considerable altitude in lat. 78° north.

Reasoning from such facts, all geologists are agreed in considering the shingle, mud, gravel, and beaches in which animals of the Arctic region are imbedded in many parts of Northern Europe, as decisive proofs of a period when a glacial sea covered large portions of such lands; and the only distinction between such deposits in Britain and those which were formed in the Arctic Circle is, that the wood which was transported to the latter has been preserved in its ligneous state for thousands of years, through the excessive cold of the region.

P. S.—Since the above was written, Capt. Collinson transmitted to me an instructive collection of rock-specimens, collected during his survey. Most of them show the great prevalence of crystalline rocks along the north coast of America.

ART. XLI.—*On Serpentine Rock;* by AUG. A. HAYES, M.D., Assayer to the State of Massachusetts.

HAVING been engaged in testing the resisting power of a beautiful variegated serpentine, proposed as the material for a base of the monument in memory of Benj. Franklin, to be erected in this city, I have been led into a somewhat extended research, on the chemical composition of serpentine, from well known localities. 1st, Serpentine from Roxbury, Vermont. The quarries in this township, are in the immediate vicinity of the line of the Central Rail Road,† at a higher level, permitting advantageous working. Rough from the quarry the rock presents a mixture of tints from dark blackish green to snow white, often finely blended, though not generally shaded. Mere physical examination shows a variety of included minerals, such as talc in scales, compact and fibrous asbestus, dark green chloritic rock, and talcose and argillaceous slates with chromic iron. These minerals make the largest part of the mass and being generally angular, though sometimes rounded, their contact lines are variously modified. Uniting these into a remarkably compact mass, is a white, or white colored mineral, which constitutes a true cement.

This rock has received the name of Verd-antique Marble, a name not only incorrect, but conveying a false conception of its

* In Parry's 'Voyages' (page 61) we learn that a number of marine shells, of the *Venus* tribe, were found imbedded in the ravines of Byam Martin's Island; a fact which strengthens the view here adopted of the submergence of large portions of these tracts at a very recent geological epoch.

† These quarries are in a belt of magnesian aggregates, which extend within the State from New Fane northerly to Troy, and may be a continuation of the Massachusetts belt. Specimens from New Fane, Proctorsville, Roxbury, Kellyvale and Troy, are found in most mineralogical collections.

composition chemically, and of its value in a technical sense especially as regards its durability. It receives a high polish and its surface then exhibits a beautiful contrast of dark green and white colors, in forms of clouds and mottling in a manner pleasing to the eye, while the asbestus and other included minerals, have a play of lights equalling that of some gems.

The enduring character of the rock places it in the class of granites and syenites and fits it for external use, as well as for internal decoration and various purposes in the arts.

Through the kindness of Dr. T. Brewer I added to my collection of samples of the rock, some nearly pure pieces of the white portions, and the analytical results which are here detailed may be taken as representing in a general manner, the composition of the varieties hitherto quarried. Before these analyses were made, the composition of this rock, had been stated to be

Silica,	42·6
Magnesia,	35·5
Protoxyd of iron and Chromium,	8·3
Carbonate of Lime,	0·6
Water,	13·
	100.

The proximate method was adopted in this as well as similar cases by myself, and I may here remark, that the success of its application has been so great, that little doubt exists of its taking the place of other methods, in the study of the more truly simple minerals—as well as aggregates.

I. Analysis. That part which is purely white in color, can be separated from the general mass, in the form of milk-white fragments, translucent, crystalline; the cleavage planes reflecting a high lustre. In hardness exceeds any variety of calc spar; it scratches the harder dolomites. The powdered mineral loses some humidity at 212° F.; at 450° the whole loss is 0·08 per cent.

100 parts of the dried powder, consist of

Carbonic acid,	48·80
Magnesia,	45·60
Talc and trace of Silicic acid,	3·60
Silicate protox. iron,	1·96
	99·96

proving it to be an *anhydrous carbonate of magnesia.* In diluted acids it hardly effervesces until heat is applied, and then exhibits an astonishing power of resistance to solution at the temperature of ebullition. The powder exposed to heat, requires long calcination at bright redness for the expulsion of its carbonic acid, rendering its estimation difficult. This character may have caused an error in previous analyses of serpentine, and led to the

conclusion that a hydrate of magnesia forms a part of the composition of all such rocks.

II. The following results embrace the averages on compact, nearly white portions:

Moisture,	0·08
Water from hydrated minerals,	0·98
Carbonic acid,	47·16
Magnesia,	44·24
Talc laminæ and trace of Silicic acid,	5·20
Silicate of alumina,	0·64
Protoxyd of iron from Sil. iron with manganese,	1·53
	99 83

showing the influence of a small admixture of the included minerals.

III. In the following results, the average of the whole rock as quarried is given, the dark greenish black, light green, and white colors, intermixed—

100 parts divide into

Moisture,	0·40
Carbonate of magnesia,	38·00
Included minerals,	61·60
	100·

61·60 of the various minerals forming the base of the compound rock, consisted of—

Combined water,	6·44
Silicic acid,	36·92
Magnesia,	10·52
Protoxyd manganese and proto-peroxyd of iron,	4·80
Alumina,	2·06
Chrome iron,	0·63
	61·37

The basis rock, thus proved to be the hydrated ingredient, is an indefinite mixture of so-called serpentine. It is however easily resolved into greenish-white talc, asbestus in various forms, rarely actinolite, ordinary slate as silicate of alumina and iron, constituting an aggregate. But the most remarkable fact is, the entire absence of the compounds of lime.

In view of this chemical composition and its physical characters, I propose that this rock quarried for ornamental purposes, be hereafter called serpentine marble.

Some early analyses of mine had shown the presence of carbonate of magnesia in the serpentines of Troy and Mt. Holly in Vermont, which also are aggregates of magnesian rocks, with some argillite. To represent more accurately the relations of

these so well known serpentines, I next chose as the subject of analytical trials the rock occurring in the township of Cavendish, village of Proctorsville, Vt. This mineral has been described as a serpentine, and its physical characters generally, entitle it to be so considered. It is traversed by thin white veins producing a variety in its otherwise deep green color. The averages of a number of samples are included in the following determinations.

IV. 100 parts of the Proctorsville serpentine afforded—

Moisture,	0·40
Carbonic acid,	17·05
Magnesia,	16·00
	33·45

as the cementing material, leaving 66·55 as basis rock, composed of—

Combined water,	6·21
Silicic acid,	36·10
Magnesia,	18·70
Proto-perox. iron and manganese,	3·40
Alumina,	1·13
Chrome iron,	·92
	99·91

V. 100 parts afforded—

Water,	5·60
Carbonate of magnesia,	26·40
Basis rock,	68·00
	100·00

A number of similar determinations were made on the rock obviously composed of talc and compact asbestus, cemented by a small proportion of carbonate of magnesia, in an anhydrous state.

The serpentine of New Fane also afforded carbonate of magnesia, in variable proportions, whilst the so-called serpentine of Lynnfield was long since proved to be in part carbonate of magnesia, cementing a rocky base including argillite.

Several European specimens, from unknown localities, were found to consist of associated magnesian minerals, cemented by anhydrous carbonate of magnesia. As a general expression, asbestus is the most abundant simple mineral and it presents itself under forms, in which it is recognised with difficulty; talc is also largely intermixed, in the basis rock. The coloring material of serpentine is found in several minerals and although here included as a silicate of the proto-peroxyd of iron, I have deemed it worthy of a particular examination, at a future time.

16 Boylston st., Boston, 26th March, 1856.

ART. XLII.—*An account of an Indicator Stage for Microscopes;* by A. S. JOHNSON, Albany, N. Y.

IN October last Messrs. Grunow of New Haven completed for me and adapted to my microscope a moveable stage, upon the principles stated by Prof. Bailey in his article upon the Universal Indicator. Carrying out his suggestions, they have succeeded in overcoming the difficulties which were pointed out as likely to attend attempts to apply the indicator to moveable stages. The indicator stage combines all the convenience of the best moveable stages, with all the advantages to its possessor of the universal indicator. By means of it all parts of a slide can be rapidly brought by equal sweeps under examination and the noteworthy objects registered. The registration is identical with that obtained by the universal indicator.

The stage is composed, as is usual, of three plates of which the lower is fixed. Upon it the other two move $1\frac{3}{5}$th inches from side to side; the top plate moves forward and back $1\frac{1}{5}$th inches upon the middle plate. The motions are effected by racks and pinions, the milled heads of which are under the stage. In the bottom plate are inlaid two scales graduated in 50ths of an inch, which extend from the middle of the side edges towards the centre of the stage. That on the left is graduated from 0 to 50; that on the right from 60 to 110. In the middle plate are two similar scales, extending from the middle of the front and rear edges of the plate towards its centre. The front scale is graduated from 20 to 50, the other from 50 to 80. Over each scale projects a steel index attached to the plate above, to facilitate accurate reading of the scales. Upon the top plate is engraved a horizontal line passing across the stage, intercepted of course by the hole in the centre, but so drawn that continued across the hole it bisects horizontally the field of view. At right angles to this line two others are engraved each crossing it on opposite sides of the centre at the distance of one inch from the centre of the field of view, which is also the centre of the stage.

The position of the several scales is adjusted with reference to these lines as follows. When the horizontal line, continued across the hole in the stage, bisects the field of view, the indexes attached to the front and rear edges of the top plate stand at 50 on the two scales of the middle plate. As upon the universal indicator the horizontal line at 50 also passes through the centre of the field of view, it is obvious that the positions of that line and of the horizontal line on the stage are identical.

The verticals being each an inch distant from the centre of the field of view at their intersection with the horizontal line, and one inch being also the distance on the universal indicator

from its centre to the points 40 and 70 in its horizontal line, the right hand index is made to stand at 70 on the right scale and the left hand index at 40 on the left scale. When the stage is set at 70 and a slide placed on the stage with its right vertical in coincidence with the right vertical on the stage, its position will be the same as if the slide were placed upon the universal indicator, with the right vertical at 70 of its horizontal graduation. It is hardly necessary to add that a motion of the stage carrying the slide is exactly equivalent to a motion in the same direction and of the same extent of the slide alone upon the universal indicator.

The top plate of the stage is furnished with a slide holder moving in grooves, by means of which a slide may be easily adjusted so that its horizontal guide line shall coincide with the horizontal line on the stage. This adjustment having been made, its right or left vertical is to be made to coincide with the corresponding vertical on the stage. The right verticals are to be used for numbers of the horizontal graduation from 60 to 110, and the left for those from 0 to 50.

In case of an object already registered, all that remains to be done is to move the stage by the milled heads of the pinions till the indexes stand at the registered numbers, and the object will at once be found. In case of a slide not registered when an object is found which it is desired to record, a glance at the indexes will give the proper numbers to be recorded.

It will be noticed that the vertical graduations extend only from 80 to 20. This being equal to $1\frac{1}{5}$th inches, affords ample room for all ordinary slides not covered with paper. But as some slides are still so covered, provision has been made for them. On the stage parallel to the horizontal line two others are engraved each $\frac{2}{5}$ths of an inch distant from the first. This distance being exactly equal to 20 divisions on the scales, in order to find an object registered by the universal indicator from the front edge of the slide, the same edge must be brought to the front line and the stage be set at 20 more than the registered number. If on the other hand the registration has been made by the lower edge, the rear line must be used and the stage set at 20 less than the registered number. In registering objects on such slides by the indicator stage, the registration ought always to be made as the numbers would appear on the universal indicator. To effect this it is only necessary, if the front line be used, to deduct 20 from the number indicated, if the rear line to add 20.

The manipulation with this stage is by no means complicated. With the stage before you, it can be mastered in ten minutes, and when once mastered its convenience and value are great. Registered objects can be found and new ones registered with great rapidity. To illustrate the great saving of time which it effects,

I may say, that in less than four minutes, I put upon the stage and adjusted a slide and then found and brought to the centre of the field of a ½-inch object-glass ten recorded objects, for each of which both sets of numbers were different. It is true that I made haste, but I know no other method by which it could have been done in twice the time. One minute may then be reckoned as the maximum time requisite to find any recorded object. How great a gain this is, every one will feel, whose time and patience have both been many times exhausted in searching to rediscover some minute object, before the indicator was invented.

ART. XLIII.—*On the Earthquake of April* 2, 1851, *in Chile*; by Lieut. J. M. GILLISS, A.M., U. S. N.*

FOR several days previous to April 2nd, the sky had been unusually overcast, the barometer fluctuating as it does during winter rain-storms. Not far from 9 o'clock, on the the night of the 1st, there was a vivid, quick flash of lightning to the NNE, so intense in brightness as to illuminate within the observatory, where I had been at work some hours. I was startled by the sudden brilliancy, and listened for close-following thunder, but no sound came; neither was the flash repeated, nor was there the smallest speck of cloud even about the horizon in that direction.† Coming down the hill, about midnight, my left eye was found to be injured by over-exertion; and the pain which soon followed brought on nervous restlessness that kept me awake several hours. Sleep, long courted, came so profoundly at last, that when nature, in wrath, was shaking the city on its foundations, and a startled population fled with cries of terror, though roused by the incipient shock, nearly half its violence had passed before full consciousness returned. Habit brought me instantly to the floor, watch in hand, and in such a position that I could embrace, at a glance, the roofs across the street, a little mirror directly in front, and the wash-stand diagonally to the right. But reason was torpid. Though there was a consciousness of excessive oscillation of the floor, and most infernal subterranean roarings; a recognition that the pictures of the paper on the opposite wall were waving from side to side across the mirror; a conviction

* From the Report of the U. S. Naval Astronomical Expedition to Chile, by Lieut. Gilliss, vol. i, p. 108.

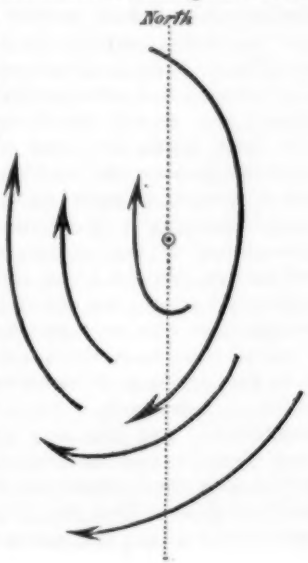
† Many of the most intelligent persons in Chile regard earthquakes as due wholly to electrical agency; and as we have no right to reject popular belief until every phase of the phenomenon is satisfactorily explicable without such influence, it is proper that the occurrence of such remarkable lightning—so short a time before the shock, and in the direction from which it came—should not be omitted. For the same reason Humboldt mentions (*Rélation Historique*, Liv. IV, Chap. 10) "two strong shocks simultaneously with a clap of thunder."

that the roofs and tiles of the houses in front were "dancing like mad;" and knowledge that the affrighted people were invoking the mercy of their God in the utmost distress, and the rattle of windows and doors was making no small addition to the uproar, still several seconds must have elapsed before I could realize the actual magnitude of the storm agitating the crust of our abiding-place. Nevertheless, experience having taught that the phenomenon is of little continuance, there was sufficient rationality to prevent my leaving the room; and I stood with senses gradually returning, thinking each vibration would be the last. But I watched and watched the dial of the monitor in my hand, and, instead of subsiding, there came accessions to the force of the moving power with each beat of its balance-wheel, till the walls on either side were swaying to and fro, the plank ceiling screeching overhead, and finally the doors flew open, exhibiting the opposite room filled with a cloud of dust, and its floor covered with broken adobes, which had fallen between the ceiling and walls. Half a minute had now elapsed, each second of which seemed at least a day; and in the fiercest violence, as the creaking of the ceiling was too ominous to disregard longer, I found myself creeping for shelter beneath the lintel of the door. Of a sudden the wall swayed away from the roof, showing the blue sky above, and a mass of rubbish fell, blinding and almost stifling me; so that it became necessary to take refuge under the lintel of the outside door, where fresh air might be obtained. As the tiles were falling in a shower from the roofs, escape to the patio was more hazardous than to remain under the doorway; for one had better risk being partially buried than have his head split with one of these heavy pieces of earthenware.

The motion had now become fearful, and the roar of the pent up vapor, as it moved heavily along, most awful; yet every little while there would reach me the clear ringing laugh of one of the assistants—inspired by the efforts of a companion to attain a place of greater apparent safety—marked contrasts of expressed human sensations in this terrestrial convulsion. I was not conscious of fear at any instant, nor was it possible to make the mind realize that the house might fall, although the walls were breaking all round, and at every few seconds the sky was visible through their crevices; but there was a sensation of dread—a feeling of absolute insignificance in the presence of a power that shook the Andes as willows in the breeze. I was humbled to the dust. Afterwards I learned, that among the mass in the streets there was but one thought, one desire—*flight*. But where fly to? The massive stone arches of the sanctuary had been broken, their key-stones had partially fallen, and the priests had been driven from the altars by masses of masonry precipitated around them; the hills were shaking huge rocks from crests

where they had slumbered since the dawn of nature, their trains marked by streams of fire; in the streets tiles were falling in showers mid clouds of dust; and on the open plain, in addition to that most unearthly and distressing noise and the moaning of cattle in their brute terror, the trees were waving from side to side under the influence of that same unseen but omnipotent agent.

Preceded some seconds by the usual rumbling noise, the first shock commenced at $6^h\ 48^m\ 10^s$ A. M., and for eighteen seconds continued with nearly uniform violence, equal to, and in the kind of motion not altogether unlike, that of December 6th. This started the tiles and walls, though it broke nothing, a fact which may perhaps be accounted for by the greater rapidity with which the atoms at the surface of the earth were disturbed on the last occasion; for, if one may judge from bodily sensations, the shaking was certainly as great as in December, though the effects were much less. The most excessive displacements were between $6^h\ 48^m\ 28^s$ and $6^h\ 48^m\ 53^s$; and at $6^h\ 49^m\ 38^s$ terminated an earthquake unparalleled in central Chile since 1822. Less than one minute and a half: a brief period of one's life when marked only by events of ordinary occurrence—but an age when one stands on a world convulsed. Beginning at $6^h\ 48^m\ 28^s$, the oscillations, then quite distinct, rapid, and abrupt, were of such magnitude that one involuntarily sought support; and though this actually lasted only twenty-five seconds, the time seemed endless, when measured by the multitude of thoughts crowded into it. Liquids were tossed to the north and south; and at the end, the surface of the mercury in a cup with vertical sides was left 1·4 inch below the rim. A barometer suspended on a north and south wall was thrown down, and all objects not summarily shaken off were moved by successive jolts to the north or south; generally in the latter direction. Every wall in the house was broken, some of them so that day-light shone through; others were thrown permanently out of the vertical, and scarcely a tile remained in place on the roof. Our pendulum was still gyrating when we could venture into the room where it was kept. Unfortunately the board supporting



the glass for the register had not been secured to the ground, and was transferred during the severe agitations nine-tenths of an inch W by N, as well as thrown out of the horizontal plane. Thus it gave broken instead of closed curves precisely as represented here, which are traced from the original sheet.

But the direction of the moving power admitted of no doubt, the point of the pendulum having passed along a line very nearly S by W, and then described nearly elliptic curves, the major axis of one of which probably exceeded four inches. Observations of this character would be of high interest, could they be obtained in numbers; but local causes, as the geological formation, orology, &c., influence both direction and apparent violence to such extent that isolated observations are of little absolute value.

We suffered on Santa Lucia too. Whilst we were dressing our servant had been despatched immediately that the great shock ceased, to learn the condition of the instruments. Following a few minutes later, the rocky mass was found broken across from east to west between the observatories and castle, and a crevice remained, which, at the surface, was nearly an inch wide. A glance showed the instruments uninjured, but one of the piers supporting the meridian circle (the western) had been greatly disturbed. These piers are composed of three blocks each, forming massive obelisks six and a half feet high above the floor, and two feet square at the base, secured to each other and to the base of porphyry *in situ* with hydraulic cement. The joint nearest the floor of the west pier was opened; the blocks, no doubt, rocked, and the whole pier was shifted to the south, until it formed an angle of 5′ with the eastern pier. Our clock had not been stopped, or rather we found the pendulum oscillating; but observations proved that it had been retarded eleven and a half seconds! Every other pendulum clock in Santiago had come to a stand.

The streets were filled with an excited and still greatly alarmed multitude, wandering from place to place in examination of the ruins of walls and turrets, and the masses of tiles and rubbish that occupied a portion of every thoroughfare.

Where the tiles had not fallen, the roofs looked as though ploughs had upturned them; and men were at work in all directions pulling down the tottering ones. With every brief interval a new shock came, and one can scarcely conceive the terror and consternation with which many rushed from their doors at these times, or the despondent anxiety settled on the countenances of all. The injury throughout the city was very severe, and the loss of walls, roofs, glass, and furniture, extensive. On the Plaza the cathedral suffered most seriously; all its arches north and south were sprung, and the key-stones settled an inch or two; the tie-beams securing the outer and longitudinal arches

in the same direction were drawn almost out of the walls, and masonry had fallen in piles. It was found necessary to close it forthwith. The central dome of the old palace and its western parapets were so broken that they were immediately pulled down to prevent further injury. Examination of these fractures showed that bricks had given way in many cases when mortar would not; and adobe walls had more tenacity than burned bricks, yielding to the flexure of the foundation without entire prostration. In every instance where objects could fall freely, they had gone off to the northward; though if not precipitated at the first shock, they generally jolted in the opposite direction. East and west of the line of motion through the Plaza, much less damage was done, a fact also peculiar in the December earthquake.

The loss of life was small. Three persons only were ascertained to have been killed, and some thirty or more wounded. Of the fatal cases—all women—two deaths had been caused by the fall of the cornice in the church of San Francisco, as the congregation rushed out; and the third was a poor girl who proved a victim to a custom of the country. In conformity with this custom, she could not be left alone, in an open house, whilst her mother attended early mass, and had been locked in the second story. When the earthquake came, she leaped in terror from the balcony, and the mother returned to find her a corpse.

There was a striking peculiarity about the great shock. Like a tense chord rudely struck, its vibration was perceptible for two hours without intermission; and its subsidence was so gradual as to leave one almost in doubt when it actually ceased. In addition to this, a somewhat similar vibration from $6^h\ 30^m$ to $8^h\ 30^m$ P. M., and a multitude of "slight tremors," we have the recorded times of eighteen sharp earthquakes before midnight. Two of the last, following at an interval of two seconds, appeared the effect of sudden and distinct explosions, without noise or tremor, unlike every motion we had felt, and Lieut. MacRae, in his surprise, writes them down "two distinct and sharp thumps underneath." The first of these occurred at $7^h\ 33^m\ 36^s$, the other just two seconds later. The most severe subsequent shock during the day was at $11^h\ 34^m\ 36^s$, which lasted seven seconds. By this time most of the populace had lost something of their apprehensions, and, having the magnitude of their sins brought thus pressingly to mind, had again flocked to the churches in numbers. As this was the season of lent, when the churchman expects to accomplish so much by compliance with prescribed ordinances, it is not difficult to believe that many would be reminded of their short-comings at mass, vespers, and confession, by such visitants as the morning had brought us. But there were few whose faith in the altar persuaded them to abide at its feet during the shock—none willing to return for the completion of devo-

tions when the shock had passed; and the streets were again filled at a most unusual hour.

Most deplorable intelligence was soon brought from the neighboring villages and *haciendas*. Lampa and Renca, lying to the northwest, were reported in ruins; their inhabitants in the streets, and the dwelling-houses and dividing walls of adobes on the estates lamentably destroyed. By night there were travellers from Curacavi, a town of 5,000 people on the Valparaiso road, and beyond the first range of mountains. Among them was Mr. Campbell, the engineer of the Copiapó and Caldera railroad, who had passed through it about two hours after the earthquake. In many parts of the town of Curacavi he saw numbers of houses whose roofs had fallen in; and scarcely one remained which could be regarded safe so long as the agitation continued. At the first great shock a portion of the church steeple had been flung to NNE; other portions fell by degrees, crushing the roof and wholly destroying the building; but these latter had been prostrated in every direction. At one of the inns the earth had opened in a nearly east and west line, entirely across the court-yard; and the water of its well was rendered turbid for several hours. The same thing occurred with a number of the wells at Valparaiso. At Casablanca—still farther west—the destruction was even greater, no walls having escaped unbroken, no matter what their direction; indeed it was said, that the only safe house remaining was the inn. This was, undoubtedly, exaggeration, fright in the first hours having driven many to arbors and tents, which they were willing enough to abandon after a day or two. There were accounts, too, that the earth had opened in a great many places near the line of the road, particularly some three or four leagues west of Santiago, and also that water had been seen to issue from the crevices in considerable quantities; but subsequent investigation brought to light only one person, to the westward, who had actually seen water ejected, and this was near Viña la Mar, close to the sea-shore. It was also well attested, that the high bank of the Angostura (a little stream emptying into the Maypu) had opened, and a black and slimy substance oozed out. Unfortunately, when searched for some five days afterwards, a heavy rain had intervened and obliterated all traces.

As no intelligence from Valparaiso reached us before the arrival of the mail, next morning, the omen was regarded as most favorable. Yet it did not prevent the assembling of an immense crowd about the post-office at the hour when the letters were expected, and anxious impatience could only be gratified by one of the clerks reading aloud from the first paper obtained. This stated, that all the walls of houses in the Almendral had been shaken to their bases; many roofs wholly destroyed; the tiles of others flung into the streets; full five hundred houses were unin-

habitable, and more than that number of people without any shelter whatever; and in short the residents remembered no such earthquake since 1822. Even those whose houses had not been seriously injured in many cases took refuge on board ships; others fled to the hills, and others again erected tents and wooden shanties in the plazas. The hotels, principally occupied by strangers, were deserted at once, the occupants taking to the water forthwith. It was especially remarkable, at Valparaiso, that the houses built on the sandy foundation of the Almendral were far more injured than those on the narrow rocky ledge of the port. Though the injuries had been greatest to those whose walls stood in a NE and SW line, no direction had proved a safeguard; and, as at Casablanca, every one in the Almendral had been broken.

Judging by a line in which a cross was thrown from the steeple of La Matriz church, and the place at which part of a marble fountain in the Plaza Victoria was left, the direction of the earth-wave must have been from NE-by-N to SW-by-S, the cross having been thrown nearly twenty feet from the body of the edifice in the former direction, and the vase of the fountain jolted on its pedestal two inches towards the latter point.* No lives were lost, nor were any serious wounds received, the hour of the day and long interval of warning having given people a chance to escape to the streets and patios. The family of one friend in the Almendral had been in agonizing tribulation. At the first tremor, the door of their chamber was permanently secured by the sinking of the ceiling; and they found themselves wholly unable to escape to the rescue of their children, occupying an apartment on the opposite side of the patio. Cries from the nurse told them that the door of her room was similarly beyond her power to force; and the thought passed through their minds that they would be buried without again embracing their children. But a moment after, the iron railings barring all the windows fell with a crash from the nursery, and the mother had the intense joy to hear the woman escape with her treasures. Then her husband and self lay down, not ready perhaps—and certainly not willing—but expecting and resigned to die, now that their children were safe.

Of eighteen shocks recorded at Santiago before midnight of the 2nd, some occurred whilst the assistants were at work on Santa Lucia, and of these they distinctly recognised the warning noise to the NE, in one instance, full fifteen seconds before the earth under foot was in motion. Most of them were slight: some lasted only a second or two; others continued nearly a quarter of a minute; and others again were followed at very brief intervals, as one or two seconds, by other tremors. Some

* Personally verified.

were preceded and accompanied by a rumbling noise, others were wholly in silence, and there was more than one instance of noise without the least perceptible disturbance.

On the following day I started for the purpose of examining the line of destruction in a southerly direction, and soon found that the effects diminished as the plain widened. Even at the Maypu, sixteen miles south of the city, had not attention been previously occupied, one would not specially have noticed crevices in the walls. Though the toll-receiver assured me he had seen large masses of earth thrown down from the vertical banks, on the south side of the stream, its bridge, with high abutments and supporting piers, was wholly uninjured. No crevices could be found in the banks near the bridge.

On a line west of the latter, where the Maypu passes through the Central Cordilleras, the latter make a sudden bend eastward; and the Andes—at a nearly opposite point—curving to the westward, the two chains closely approach each other at a pass twenty miles south of the stream, called the Estero de Payne. Indeed, the two chains of mountains, here about two thousand feet above the plain, are separated by a gorge of the same level as the plain, whose average width is not more than one hundred yards. Thus from the Cuesta de Chacabuco to the Angostura, except where the Maypu passes through the central range, there is a continuous though irregular elliptic plain, whose diameters will not vary greatly from fifty-five and twenty-five miles. The widest part of the basin or plain is where the Maypu crosses it in latitude 33° 42′, and here the high road to the south seemed to be near the eastern line of injurious disturbance. Subsequently, we learned by a traveller from Mendoza that a very slight though long tremor had been felt at 7^h 10^m, in that city, on the morning of the 2nd.

Proceeding toward the Angostura, from the Maypu, every quarter of a mile exhibited increase in the extent of injury done; and within a league of it, the destruction was excessive. Not only had houses, walls, and division lines been more completely destroyed than about the capital, but losses had been more universal. Neither dimension nor material of wall had saved it; those of adobe, thirty inches thick and extending round two sides of a parallelogram one hundred and twenty-five feet each way, were perhaps broken rather more frequently than short partitions, though not so much so as masonry. In one case the back wall of an old store-house was lifted bodily to the north and set down two inches from its former foundation; whilst a short piece at right angles to it, forming a sort of abutment to its eastern end, was shaken down piecemeal. The wall stood nearly east and west, was of adobes eighteen inches thick, some eighty feet long and nine feet high. Nothing but the roof, itself partially

sustained by the stakes of an outer corridor, prevented the whole from going over. In the parlors to the mansion of this *hacienda*, things were thrown in all directions: lamps, chairs, books, fell in every possible line, almost inducing belief that the increasing resistance offered to the onward movement of the explosive agent by the rapidly approaching mountains, had converted rectilineal into gyratory motion. These objects fell in the several directions at different periods.

At the time of the shock, the proprietor was in the fields giving orders for the work of the day. Turning at the first rumble that reached his ear in the direction of the mansion, where his wife and children were, he put spurs to his horse, which had not yet become frightened. But an instant after, the poor brute suddenly stopped and spread out its feet, giving expression to the utmost terror by deep-breathed snorts and starting eyes, nor could any punishment make it move until the phenomenon had ceased. Apart from thoughts of his loved ones, this was a trying interval to my friend. Alone, and all nature convulsed! The earth heaved and trembled till foot-hold was not secure, its profoundly vaulted caverns pealing thunders stunning to the ears; the atmosphere was serene and balmy without a stirring breath, yet trees around were waving and bending half way to the very soil as in a storm; flocks of birds in rapid flight screamed their sympathy; and herds of cattle came tearing down the mountain sides, pursued by great boulders of granite, mid clouds of dust and sparks of fire.

Along the line of the road beyond the Angostura, there were scarcely any visible effects; and although the inhabitants of Rancagua say that the shock was extremely severe, there were only a few small crevices in the higher walls. If not exhausted to the northward of the gorge, the strength of the earth-storm had evidently passed to the westward of it, a supposition to which neither examination nor inquiry lent their support. The mountains *had* arrested the progress of the great earth-wave, and the re-action of its generating power was plainly exhibited on the alluvial strata of the deep terrestrial bay.

Travellers from as far south as Talca stated that the shock had been quite moderate at that city, and none had given it a thought beyond the Cachapual, except for its unusual length. Nearly all of them, however, as did those north of the Angostura, believed that its origin had been to the southward. Whilst at Rancagua, a violent rain-storm commenced on the morning of the 5th, preceded by excessive thunder and lightning. This was a widely extended storm, reaching from latitude 33° to latitude 40°.

As nothing further was to be gained in a southerly direction, I returned to Santiago, and two days afterwards crossed the axis of the earth-wave in the direction of Valparaiso, though without

obtaining many new facts to relate. The disturbance had certainly been greater at Curacavi and Casablanca than at the capital and port, much property having been so injured that it was necessary to tear it down. Repairs were out of the question, for the walls were no longer stable. One crack in the earth, west of Casablanca, at the surface, was still nearly three inches wide, and about two hundred yards long. Its general direction was WNW and ESE. The same fact was observed on the Almendral as had been remarked near the Angostura; objects were thrown from tables and shelves in every imaginable direction, as though each vibration was from a different quarter. No special agitation was observed at the surface of the sea, nor did any great wave follow to wash away prostrate buildings, of which some forty were level with the ground. One of the papers stated that a lead line thrown overboard at the time from the U. S. frigate Raritan, was so buried in the sand that it could only be extracted with great difficulty; but this, like many of the wonderful stories told of earthquakes, should probably be received "*cum grano salis*;" else we must conclude that the ships, being unable to heave them up, probably left their anchors in the bay when about to sail. There was no indication whatever that the shores of the bay had been raised either by the great shock or the multitude of smaller ones continuing throughout the succeeding fortnight. I examined the rocky shores closely during several tides, but could find no unprotected memento.

Mr. R. Budge, F.R.G.S., considers* the motion to have been westward, because water in basins, jugs, &c., spilt over the east side; clocks whose pendulums vibrated east and west stopped, while those beating north and south did not; walls standing east and west were cracked in every way—particularly lengthways, and vessels at sea felt it at an hour corresponding to the difference of longitude. He supposes the phenomenon to have been subject to instantaneous cessations, and says that it turned round things on their base instead of throwing them down at an angle of 20°, showing a circular motion for at least an instant. I shall have something to say presently respecting the two vessels which felt the shock at sea. He goes on to remark: "I have experienced at this place (Valparaiso) three ruinous earthquakes—that of 1822, which I passed in the house until the back fell, that of 1829, and the present. On the last occasion the barometer and thermometer indicated nothing, nor was there the least warning of any description; but, as invariably occurs after a heavy shock, we had, on the third day after, a shower of twelve hours' rain, for which I had already prepared, aware of its being the consequence, happen whatever season it may. I conceive also that I have felt less relaxed than before it. I cannot understand all

* Report of British Association, 1851.

these things, unless electricity be the agent; while the atmosphere must be affected in some way to shower down rain at seasons when, under ordinary circumstances, it does not fall. * * * On that occasion (1822) the sea in the bay of Valparaiso retired considerably, and was several days in reaching its former level; while on this, no such thing was observed."

Only two vessels bound to Valparaiso felt the shock. One was forty miles to the southwest of the port, and the other a like distance to the northwest, and therefore they were some fifty-seven miles apart. Until he learned, after anchoring, that an earthquake had occurred on the morning of the 2nd, the master of the former was fully persuaded he had passed over a reef of rocks; the other felt no shock whatever, though at the time designated the crew had heard explosions like distant discharges of heavy artillery. San Antonio, near the mouth of the Maule, and Talcahuano, both experienced a tremor; Melipilla, between San Antonio and the capital, felt it severely. There was a violent shake at Quillota, also, and San Felipe de Aconcagua suffered some injury. Even the Copiapó papers mention a "*temblor*" on the morning of the 2nd; but nothing special was remarked, and it passed as one of those occurring almost daily.

Efforts to obtain reliable data for determining the velocity of earth-waves meet with little encouragement among those with whom "*mañana*" (to-morrow) is proverbial, and who have not yet learned that a few minutes are worthy of appreciation. Moreover, people generally are too much alarmed when the shock comes. Eternity occupies more of their thoughts than time; and had they self-possession to record the instants, probably no two time-keepers in the city agree within several minutes. Of the great shock one Talca paper says, "this morning a quarter before seven;" the other, "at twenty minutes past six in the morning." Even in Valparaiso, where government has placed a clock visible to nearly all the town, the papers differ two minutes, though the custom-house clock was stopped by the shock at $6^h\ 42^m$. But here are the Santiago mean times at which the greatest shock was felt at each place, with its bearing and distance from the capitol.

Name of city.	Time.	From Santiago.	Distance.
	h. m. s	°	*Miles.*
Talca,	6 25 00 6 45 00	S. 21 W.	112
Santiago,	6 48 40·5		
Valparaiso,	6 44 55·5 6 45 55·5	N. 67 W.	64
Quillota,	6 48 49·5	N. 62 W.	64½
San Félipe,	6 44 12	N. 16 W.	45
Mendoza,	7 03 18	N. 73 E.	105

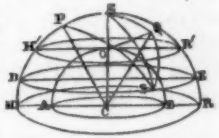
No possible supposition will reconcile them.

For days—it may be said weeks—after, the whole district of country disturbed by the principal shocks was visited by tremors. At Santiago the times of four were noted on the 3d; only one on the 4th; two or three on the 5th; and so on up to the 20th; indeed, for several months their occurrence was more frequent than during the same period of the preceding year. Having passed from the afternoon of the 6th at Aguila, the hacienda of a friend within the deep bay of the mountains, there were opportunities to experience some of them in the open fields.

ART. XLIV.—*Supplementary Note to the article on the Theory which attributes the Zodiacal Light to a Nebulous Ring surrounding the Earth;** by F. A. P. BARNARD, LL.D., Professor of Mathematics and Astronomy in the University of Mississippi.

Prof. DANA,—Will you allow me space for a few words supplementary to the article on the zodiacal light, published in the March number of the Journal of Science. In that article the geographical limits of visibility of the cusps of a ring encircling the earth, lying in the plane of the ecliptic, illuminated by the sun and interrupted by the earth's shadow, are assigned for the moments when the sun is eighteen degrees below the eastern or western horizon. It is true, however, that there are certain limits of distance from the earth's centre, between which, if such a ring be situated, a certain portion of the part of it illuminated may be visible, under the circumstances supposed, as an illuminated arch, though the cusp may not be above the horizon.

In order to determine these limits, if we resume the consideration of fig. 5 in the article referred to, where AOB is the earth, HZR the imaginary spherical surface of which the ring is a great circle, H′R′ the horizontal small circle of this sphere passing through the place of observation O, S the pole of the limiting circle (i. e. the circle of the shadow), SQ its arc-radius, and Q the cusp of the luminosity, then when Q is on the horizon, the ring may touch the horizontal circle H′R′, or it may rise above it either on the illuminated or on the obscured side of Q. In the former case, a luminous arch will be visible to the observer at O. The tangency or the intersection which takes place at Q will be determined by the value of the angle at that point; contact occurring when this angle is ninety degrees, and the intersection favoring the visibility of the light, when the angle is greater than ninety.



* This volume, p. 217.

Put ⊙'s depression $=\delta$, ZQ$=\varrho$, SQ$=\varrho'$, ZQS$=$Q. Then, in the triangle ZQS

$$\sin\delta=\cos\varrho'\cos\varrho+\sin\varrho'\sin\varrho\cos Q.$$

But, by the hypothesis, $\varrho+\varrho'=90°$. Consequently $\cos\varrho'=\sin\varrho$; and $\sin\varrho'=\cos\varrho$. Whence,

$$\text{Sin }\delta=\sin\varrho\cos\varrho\,(1+\cos Q)=\tfrac{1}{2}\sin 2\varrho\,(1+\cos Q).$$

$$\text{Or, }\cos Q=\frac{2\sin\delta}{\sin 2\varrho}-1.$$

When $2\sin\delta=\sin 2\varrho$, $\cos Q=0$, and the ring touches the horizon. When $2\sin\delta>\sin 2\varrho$, $\cos Q$ is positive, and the obscured part of the ring rises above the horizon. When $2\sin\delta<\sin 2\varrho$, $\cos Q$ is negative, and the light is visible to the observer at O.

It is evident that, δ being constant, this phenomenon will be more remarkable as $\sin 2\varrho$ is greater. Putting, therefore, $\sin 2\varrho=1$, we have $\varrho=45°$; whence it is evident that such a ring as we have been considering would be most conspicuous as a luminous arch, after the setting of the cusp, provided it were placed at a distance from the earth's centre $=3956\sqrt{2}$, or 1640 miles above the surface.

If, while we make $\sin 2\varrho=1$, we make also $2\sin\delta=1$, the ring will touch the horizon, and we shall have $\sin\delta=\frac{1}{2}=\sin 30°$. That is to say, the maximum depression of the sun at which the phenomenon can occur, is thirty degrees.

If we take the sun's depression $=18°$, as in the article referred to, then tangency will occur, when $\sin 2\varrho=2\sin 18°$: which will give the value of $\varrho=19°\ 5'$, or $70°\ 55'$. If any value be assumed for ϱ between these limits, the phenomenon will be observable; but for any value beyond them it will not be observable at this depression of the sun. But the distance of the ring from the earth's centre corresponding to any value of ϱ, is expressed by the formula,

$$D=\frac{R}{\cos\varrho},$$

in which D represents this distance, and R the earth's radius. Whence the limits of distance which will make the light visible at the close of twilight or at the commencement of the dawn, though the extremity may be beneath the horizon, are 4186 miles for the lesser, and 12,100 miles for the greater, from the centre of the earth.

The inclination of the ring to the horizon when it just touches the circle H′R′ is equal to $90°-ZR'=\varrho'$. The geographical limits within which the light of a ring situated at any distance from the earth between the limits just determined, ought never to be absent in some form and during some portion of the night,

or ought never to be present at all, may be ascertained by the equation

$$\text{co-lat.} - \text{obliquity of ecliptic} = \varphi',$$

for the first; and by the equation

$$\text{co-lat.} + \text{obliquity of ecliptic} = \varphi',$$

for the second. Putting D=9000, as in the March number of this Journal, $\varphi' = 26°$; and the equations foregoing will give the latitude 40° 32′ as the limit of perpetual apparition of the light, and 87° 28′ as that of its perpetual occultation.

By assuming, in the triangle ZSQ, $\delta = 18°$, and the position of Q on the circle H′R′, we shall find that the visibility of the light as an arch of which the extremity is beneath the horizon when the sun is 18° depressed, will be limited to places between the latitudes at which the maximum inclination of the ecliptic to the horizon is not less than 26° on the one hand, and the minimum not greater than 28° 34′ on the other; and the season of its greatest conspicuousness at any given hour, or at any given depression of the sun, may be found by putting I=28° 34′ in the equation given in the note on p. 231 of the last number of the Journal,* viz.

$$\cos I = \sin L \cos O - \cos L \sin O \sin A,$$

in which I is inclination of ecliptic to horizon, L latitude of observation, O obliquity of ecliptic, and A right ascension of the culminating point of the ecliptic. The value of A being found, the R. A. of the sun follows immediately, in case the hour angle is given; and is deduced without difficulty from the depression, if that is the given quantity.

Thus at Oxford, lat. 34° 30′, the arch could never be seen at the close of twilight, unless the cusp were at the same time visible; but at New Haven, about the time of the autumnal equinox, the axis of the light ought apparently to rise two or three degrees above the horizon at the same hour, though it would be impossible to see the extremity. Some further arguments unfavorable to the hypothesis which ascribes the zodiacal light to a luminous ring encircling the earth might be drawn from the considerations presented in this letter; but after what has been said, it is, perhaps, unnecessary to add more.

University of Mississippi, Oxford, March 15, 1856.

* In case the maximum inclination of ecliptic to the horizon is not so great as 28° 34′, substitute that maximum itself for I.

ART. XLV.—*On the Presence of Vivianite in Human Bones;* by J. NICKLÈS.

IN the cemetery at Eumont, a village in the Department of La Meurthe, the earth of which is very ferruginous, there has been found among the bones, the accumulation of several centuries, two arm bones of a female, a cubitus and a radius, having a deep bluish green color. One of these bones having been broken through curiosity, it was discovered that the color was general through its whole thickness. This bone having been sent me, I have observed the following facts.

The color was decidedly greenish; but as the osseous paste was yellow, it was evident that the coloring matter was blue. By dissolving a fragment in chlorhydric acid and supersaturating with ammonia, a white precipitate of phosphate of lime slightly bluish in tinge was obtained, showing that the color was not due to copper. Reagents indicated the presence of iron; but as the bones all contained iron, it was not at first easy to ascertain whether this metal was in the coloring matter, although it much resembled phosphate of iron. My subsequent investigations proved that this last was true. On examining the medullary cavity with a lens, I found among the sinuosities left by the hardened marrow, brilliant points which were distinctly crystalline. With a microscope, they were found to be rhomboidal prisms apparently oblique, some of them surmounted with a horizontal prism, and others with octahedral planes having the terminal planes applied to the two extremities of the macrodiagonal. They were too small for measurement. But by chemical methods, they were found to have all the characters of phosphate of iron. Calcined with bicarbonate of soda, the acid and oxyd were readily separated; and on treating the calcined product with distilled water, I obtained a residue of oxyd of iron and an alkaline solution, which on neutralizing it, afforded an abundant precipitate with ammonia, chlorhydrate of ammonia and sulphate of magnesia. This was therefore phosphoric acid, and the substance a crystalline phosphate of iron, which can be only Vivianite. The presence of the bones in the ferruginous water explains its formation, the bones affording the phosphoric acid from the phosphate of lime.

This fact recalls to mind an observation made some years since by Schlossberger, who detected in the stomach of an ostrich that had died suddenly, two nails surrounded with an unctuous material of a bluish color, which coloring matter the author found to consist of a phosphate of iron, having the composition of Vivianite.

The bones mentioned above were in a perfect state of preservation, and afforded a skeleton of gelatine when treated with

chlorhydric acid, proving that gelatine does not resist the absorption of the ferruginous compound. We know nothing as to their exact age. The presence of gelatine is not a matter of surprise, as is shown by the discovery of it in the fossil horn of an Aurochs (Bos urus) by Braconnot,* and the antediluvian soup of Cuvier. They probably date back hardly two centuries. Whatever the time, they illustrate the interesting fact of the modern origin of Vivianite and the conditions favoring it.

ART. XLVI.—*Correspondence of M. Jerome Nicklès, dated Paris, March* 2, 1856.

Academy of Sciences.—Distribution of Prizes.—The annual session of the Academy of Sciences was held on the 28th of January, when M. Flourens pronounced an historical eulogium on the distinguished geologist, von Buch.

Notwithstanding the fine discoveries made this year in the departments of physics and chemistry, no prize has been given to the indefatigable workers who have contributed to the progress of these sciences.

The prize of mechanics was given to Captain Boileau, Professor at the School of Artillery of Metz, on account of his researches in hydraulics—"a science which, in spite of all the remarkable works undertaken at different times in France, England and the United States, has not yet attained to the perfection and certainty required for precise calculations in the varied cases brought before the engineer." The Academy, in bestowing the prize, includes also a recognition of the delicate apparatus contrived by M. Boileau for studying the flow of water in open channels and over dams, as well as his experimental researches on the sawing of wood, through which the author has devised new sawing machines.

A prize extraordinary in statistics was conferred on M. Le Play, the late commissary general of the Universal Exposition, for his work entitled "Les Ouvriers Européens;" another to M. Vicat, for his statistical researches on calcareous hydraulic cements. M. Vicat in his work has aimed to point out the mineralogical resources of France, with special reference to materials for constructors; the work embraces references to the minerals found in 76 of the Departments.

Among the prizes relating to the arts that are injurious to health, one of 2500 fr. was given to M. Duméry for a contrivance for consuming the smoke of chimneys, which has worked with complete success in a series of comparative experiments under the inspection of the learned mechanician, M. Combes, Member of the Commission.

M. Duméry, in place of throwing in the fresh coal by the door of the furnace upon the burning combustible, as in ordinary fires, causes it to enter below by means of stoking bars worked with the hand in a kind of recurved funnel, with open sides, and extending to the grating on that side. This method was long ago suggested by Franklin; but

* Journal de Physique, August, 1806.

the arrangements here adopted are peculiar to this inventor and attain perfectly the end proposed.

The Commission has decreed three other prizes of less importance.

As usual the Commission in Medicine and Surgery has been just and generous in its prizes. It has not confined its attention to medical and surgical works, but has given prizes as in the last year, even to researches in chemistry and physics where they have some relations to medical science. A prize was thus bestowed upon Dr. Hannover of Copenhagen for his work on the Eye; another to Dr. Lehmann of Saxony for his Treatise on Physiological Chemistry, published in German at Leipsic, and which has just been strangely disfigured by a French edition that has of the work only its title.

Aluminium and Silicium.—M. Wöhler and M. Deville have both devised easy processes for obtaining pure silicium. Wöhler uses fluosilicate of potash, $3KFl+2SiFl^3$ in excess, which he fuses with the aluminium in a Hessian crucible. After cooling, the mass is found to contain a crystalline material, an alloy of silicium and aluminium, before observed by Deville, which after treating with chlorhydric acid deposits silicium in a graphite-like state.

Deville's process affords the silicium in a crystalline state. It consists in heating the aluminium in a porcelain tube traversed by a current of hydrogen saturated with vapor of chlorid of silicium: the treatment is continued until there is no disengagement of vapors of chlorid of aluminium. The crystallized silicium contains some impurities which are removed on treating it successively with nitro-muriatic acid, boiling fluohydric acid, and melted bisulphate of soda. As long as the operation is not complete, there are found small globules of siliciuret of aluminium, $SiAl^2$. The fluorid of silicium used in place of the chlorid would equally furnish silicium; at the same time, a new compound of fluorid of aluminium, Fl^3Al^2, is formed, crystallized in fine cubes and unattacked by almost all reagents.

Silicium crystallizes in octahedrons and tetrahedrons, and conforms therefore to the rule which I established in 1851,* that simple bodies crystallize generally either in the monometric or rhombohedral system.

By the same process, Deville has prepared crystallized boron as well as crystallized carbon with a hexagonal base, zirconium, and titanium. We will recur to the subject at another time, and then describe the new apparatus, such as tubes of carbon, &c., used in these operations, as executed at the Normal School, which institution, has, through the University, extended means of research.

Artesian wells.—An artesian well is in progress in the Bois de Boulogne a meter in diameter, and capable of supplying 10,000 cubic meters of water per day. The engineer who has it in charge, M. Kind, has so perfected the process, that he offers to go to a depth of 720 meters, and even to descend to a depth of 2000 meters. The boring was commenced on the 2nd of August with a diameter of 1·2 meters. Descending through marl and soft sandstone, the rate was five meters a day; in a bed of sand it was two to three meters; by the 1st of May the depth will reach 700 meters.

* Comptes Rend., xxxii, 853.

The process employed by M. Kind is an improvement on the Chinese method of percussion. A cylindrical rod of wood, is made of sticks of young pines, ten meters in length, united by sockets of iron fitted with screws. The quantity of iron added to each piece is just that required to counterbalance the water. As water is encountered at a depth of 20 or 30 meters, and it continues to fill the hole, it results that the shaft, which, whatever its length, is thus made to equal the water in weight, has relatively almost no weight, so that it is moved by a small force; and being made of pieces of wood put end to end, its strength is very great. The extremity of this rod carries a grapple at bottom which opens as it descends, and then closes when it is raised by means of a parallelogram connected at its angles with two cords, which cords reach up to the orifice of the well, where they may be managed with the hand or by means of machinery. At the bottom of the well, there rests a drill weighing 1800 kilograms, quite similar in form to that used for pounding and drilling rocks, but armed below with seven teeth of cast steel twenty-five centimeters long, fitted to drive into the bed of rock and break or abrade it. The drill has a shank above by which it may be seized and lifted.

The mode of operating is as follows:—With a steam-engine of twenty-four horse power, working a horizontal balance beam, the rod of wood is let down. The grapple at its bottom closes, seizing the handle of the drill; it then rises, lifting the drill to a height of some meters above the bottom; the grapple then opens, and lets the drill fall; thus the drill is raised twenty times a minute. After working in this way twelve hours, the entire rod is raised along with the drill, which is done with great rapidity; the sticks of pine are taken apart in less than a quarter of an hour. They are then refitted, and the drill is replaced by a bucket having a valve below which is opened and closed also by the aid of the cords and the grapple; the bucket opens below, and being pushed by the piston, penetrates into the pasty mass and fills, after which the valve is closed, and the whole is drawn up, and the drill again sent down.

As it traverses different strata, specimens are taken, and thus a true geological section of the basin of Paris is obtained. A steam engine of thirty horse power is sufficient for all the work, and the number of workmen required is only six, costing each day 49 francs. The teeth of the borer are rapidly worn in quartz; they lose nearly two centimeters in two hours work. The mean expense of boring is per meter 54·39 fr.

Electric clock.—The city of Marseilles has undertaken to establish a complete system of electric clocks. One hundred clocks will be set up by the 1st of May. The arrangements require the laying of 40,000 meters of conducting wire. The clocks will be placed in the street gas lamps, so that the hour may be read at night as well as by day. The whole will cost only 22,000 francs, and the care and supply of them per year 2000 francs.

Chlorimetry.—The anomalies presented at times in the process of treating with hypochlorite of lime (commonly called chlorid of lime) the standard test liquors of Gay Lussac, have just been explained by MM. Fordos and Gelis. A normal solution of the hypochlorite having,

at the end of some time, lost its standard value without having lost its bleaching power, these chemists examined the liquid and found that a part of the hypochlorous acid was changed to chlorous acid, which bleaches indigo well, but does not act on the arsenous acid employed in the process of Gay Lussac.

This fact is of great importance in commerce; for on examining a hypochlorite of lime or soda, the merchant or dyer is not anxious to learn the quantity of hypochlorous acid present, but wishes to know the quantity of coloring matter a given weight of the hypochlorite will bleach.

MM. Fordos and Gélis have therefore sought for a better process; and after employing it for four years in the fine establishment founded by them on the Seine, they publish it for the benefit of the trade. They replace the arsenous acid with hyposulphite of soda, a salt that is definite in composition and unalterable of itself, which chlorous acid destroys easily. It is very soluble in water, and not poisonous, and therefore every way preferable to the arsenous acid.

Excepting this substitution, the process resembles that of Gay Lussac. 2·77 grammes of crystallized hyposulphite of soda dissolved in 1 litre of water, constitutes the test-liquor, corresponding to the arsenical solution of Gay Lussac. After having taken 10 cubic centimeters of this normal liquor, 100 parts of water are added and some drops of indigo; and as the hypochlorites are generally alkaline, and since the hyposulphite of soda does not decompose readily except in an acid liquid, some drops of sulphuric acid are added. As the solution of hyposulphite has been previously diluted with water, there is no danger that the hyposulphurous acid will be immediately decomposed in consequence of the slight excess of sulphuric acid added.

This hyposulphite is also an excellent antidote of bromine and iodine which are largely in use through the operations of photography.

Illuminating gas.—An important change has just been made in the six gas works from which Paris is lighted, in consequence of the discussions that have been going on the past two years, and large reductions have been made by the company in their charges.

From the 1st of January, 1856, the cubic meter of gas, which till then had cost the people 35 centimes, has been put at 15 centimes.

The contract made with the company is for fifty years; but at the end of sixteen years, if the annual profits exceed ten per cent, half the surplus will go to the city; and if a new mode of illumination less expensive should be discovered, it may be put in practise without any indemnity to the contractors.

An offer was made by an engineer, M. Pauton, to prove that the cost of a cubic meter of gas was much below the cost set down by the companies, which led to an examination by the government. A special commission was appointed, and an experimental laboratory having been constructed in the park of St. Cloud, nothing was neglected that would put the investigation under the best possible conditions for accuracy.

The results set forth by the company as having been obtained in the period between 1844 and 1853 are the following:—

100 kilograms of coal have produced—

Gas (C^4H^4, C^2H^4, CO), ...	21 cubic meters.
Coke, ...	69 kilograms.
Tar, ...	4·50 "
Ammoniacal liquid, ...	8·75 "

Combustible consumed in heating the furnaces, 24·75 kils. of coke.

The commission has obtained, as an average, for 100 kilograms of coal,

Gas, fit for illumination, ...	22·940 cubic meters.
Coke, ...	75·40 kilograms.
Tar, ...	6·73 "
Ammoniacal liquid, ...	7·31 "
Combustible consumed in the furnaces,	20·43 "

To the price 0·0791 fr. per cubic meter of gas set down by the companies, the commission opposes that of 0·208 fr. per cubic meter. In this amount are not included the octroi duty, laying of pipes, &c., for the 30,000,000 of cubic meters of gas which Paris consumes each year.

We cannot give all the details respecting this process which is of so immense importance to the inhabitants of Paris. The subject is presented in full in the Bulletin de la Société d'Encouragement for the month of December, 1855, to which all interested are directed.

Zoological Society of Acclimation.—This Society continues its labors with zeal and success. One of its principal importations is the Angora goat, of which we have spoken in our communication of November last. The Bulletin of the Society for January 1856, states that a similar importation was made into the United States in 1849 by Dr. Davis, six females and two males having been introduced by him into South Carolina. In that warm region, latitude 34°, it has rapidly increased, until in 1854 there are fifty animals of the pure breed, and a much larger number of mixed breed crossed with the goat of the country.

The goat has also been successful in France. The small flock at Marseilles is increasing; the other intrusted to the society of acclimation of the northeast zone, of which Nancy is the centre, and placed at first at Wesserling (Haut Rhin) is now in the vicinity of Nancy. A contagious disease appeared in the flock at Wesserling, and this led to the change. Dr. Sacc sent the goats to Nancy where they arrived at a cold and rainy time in the month of December. One of them died on the way, and the others were sick. They are now well and in the prospect of breeding. Nancy is in longitude 3° 50′ 16″ east of Paris, and latitude 48° 41′ 28″; and its mean altitude is 201 meters 46 centimeters above the level of the sea at Havre.

A kilogram of the Angora wool sells in France at six francs; and as a goat produces two kilograms, as much as a sheep, its value is three times as great. Dr. Sacc has made thread of the wool or rather hair, and sent some of it to the Society, along with a sample of velvet of the hair. The velvet has the lustre of silk and the firmness of wool velvet. But from both, it is distinguished by the surface showing no marks from pressure even if it be strong and long continued. The

Angora tissues are also colored with the same facility as those of wool or silk, which is highly important since tissues are now made of mixed silk and wool.

Bibliography.—Histoire et Fabrication de la Porcelain Chinoise; traduit du Chinois, par STANISLAS JULIEN, accompagné de notes et d'additions par M. SALVETAT. 1 vol. in 8vo. Paris: chez Mallet-Bachelier. Price 12 fr.—The Chinese, as is known, are our masters in the manufacture of porcelain. They have had some processes for ages which are still unknown to us, although we have surpassed them in other points. Thus we do not yet know how to produce at will the porcelain called "craqueleé." The book which has just appeared mentions three processes known for a long time in the Celestial Empire. The translator, whose work on the culture of silk worms and the mulberry in China has been translated into the principal languages of civilized nations, including the Russian and Arabic, may look for a like success with this new work on porcelain. It is not simply a translation. Through the aid of M. Salvetat, chemist at the manufactory at Sevres, the work has been rendered an important one to chemists and especially manufacturing chemists, notes being added and many comparisons of the Chinese methods with our own. In addition, the volume contains a chart of China pointing out the places of manufacture of porcelain, ancient and modern, and also a Chinese and French index of most of the words. It closes with a memoir on the porcelain of Japan, translated from the Japanese by Dr. Hoffmann, interpreter of the government of Holland in the Indies.

Etudes et Lectures sur les Sciences d'Observation et leurs Applications pratiques, par M. BABINET, Membre de l'Institut. 2 vols., in 12mo. Paris: chez Mallet-Bachelier. Price 2½ francs.—This work is for general circulation. It treats of—1, Turning tables and supernatural manifestations; 2, Working electricity; 3, Siberia and the climates of the north; 4, Influence of the currents of the ocean on climates; 5, on Earthquakes and the interior currents of the globe; 6, Astronomical Bulletin for the years 1853, 1854; 7, on the Water systems of the globe; 8, on Turning tables from a Mechanical and Physiological point of view; 9, Meteorology in 1854 and its future progress.

Dictionnaire Universel des Sciences des Lettres et des Arts, par M. BOUILLET. 4to. Paris: chez Hachette & Co. Price 25 fr.—In less than 2000 pages of two columns each, this work goes through in alphabetical order the different branches of human knowledge, and defines scientific, artistic, and industrial terms, with a precision and exactness which had not been realized in any other work of the kind.

La Pisciculture et la Production des Sangsues, by A. JOURDIER. 1 vol. in 12mo. Paris: Hachette & Co. Price 2 fr.—This is the first complete work on the different processes of pisciculture and on the production of leeches—a branch of industry which has had so great and rapid extension in France and elsewhere. It contains also a description of the Piscine of the College of France and that of the great establishment of Huningue.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On heat as the equivalent of work.*—Hoppe has contributed a memoir upon this most interesting and important subject which places the analytical theory in a remarkably clear, simple, and general point of view, so far at least as it relates to permanent gases. We shall give the author's investigation in extenso, making however a slight change in the symbols employed so as to assimilate them to those usually employed by writers on the calculus, in French or English. The temperature τ of an enclosed permanent gas may be expressed as a function of the pressure p and the volume v by the following formula which is a combination of the laws of Gay Lussac and Mariotte:

$$pv=\frac{ma}{\delta}(1+\alpha\tau) \qquad (1)$$

In this formula m represents the mass of the gas, a any definite pressure, that of one atmosphere for instance, δ the density at the temperature 0° and pressure a. If we consider the temperature to be measured by the increments of volume of the gas itself, α will be absolutely constant, and Mariotte's law will be the only fact resting upon experience.

Let ϑ denote the quantity of heat which the mass m of the gas must receive from without, in order to produce any changes whatever in p, v and τ. Then considering p and v as independent variables and τ as a function of both we can make

$$\frac{d\vartheta}{dv}=mc\frac{d\tau}{dv}; \qquad \frac{d\vartheta}{dp}=mc'\frac{d\tau}{dp}.$$

The magnitudes c and c', defined in this manner, express the capacities for heat at a constant volume and at a constant pressure, and may for the present be regarded as constant. Substituting in these expressions the values of the partial differential co-efficients of τ as obtained from (1) namely

$$\frac{d\tau}{dv}=\frac{\delta p}{ma\alpha}; \qquad \frac{d\tau}{dp}=\frac{\delta p}{ma\alpha},$$

we have,

$$\frac{d\vartheta}{dv}=\frac{\delta cp}{a\alpha}; \qquad \frac{d\vartheta}{dp}=\frac{\delta c'v}{a\alpha},$$

and hence for the total differential of ϑ

$$d\vartheta=\frac{\delta}{a\alpha}(cpdv+c'vdp).$$

If now the gas pass from one state to another so that p and v change according to any definite law, p, v, and ϑ become functions of each other and we have

$$\vartheta=\frac{\delta}{a\alpha}\left(c\int pdv+c'\int vdp\right). \qquad (2)$$

If τ_0 denote the initial temperature then from the equation (1) we have

$$d\tau = \frac{\delta}{m a \alpha}(pdv + vdp),$$

and if we integrate between the same limits as those to which ϑ is referred and multiply by mc' we have

$$mc'(\tau - \tau_0) = \frac{\delta}{a\alpha}c'\left(\int pdv + \int vdp\right), \qquad (3)$$

which subtracted from equation (2) gives

$$\vartheta - mc'(\tau - \tau_0) = \frac{\delta}{a\alpha}(c - c')q \qquad (4)$$

where $q = \int pdv$ expresses the work done in the change of state. The result is therefore as follows. "The quantity of heat communicated to a gas during any change of volume and pressure consists of two parts, one of which expresses the heat necessary to raise the temperature at a constant volume, while the other is a constant-multiple of the work done." In particular we infer that this quantity of heat is in itself proportional to the work as soon as the initial temperature is regained, while the pressure and volume may have other values; as pure loss of heat it appears, it is true, only after a complete restoration of the original condition.

Let us now suppose that neither Mariotte's law nor the law of the invariability of the capacities is accurately true. If c and c' are subject to any small changes in consequence of changes of pressure or temperature, we may consider them as functions of p and v and write equations (2) and (3) as follows:

$$\vartheta = \frac{\delta}{a\alpha}\left(\int cpdv + \int c'vdp\right)$$

$$m\int c'd\tau = \frac{\delta}{a\alpha}\left(\int c'pdv + \int c'vdp\right)$$

whence by subtraction,

$$\vartheta - m\int c'd\tau = \frac{\delta}{a\alpha}\int (c - c')pdv.$$

If now during the change there is only work consumed or work performed, if consequently pdv undergoes no change of sign, we may by a known property of definite integrals, place the factors c and $c - c'$ before the sign of integration, when the last equation will correspond with equation (4): only we now understand by c' and $c - c'$ certain definite mean values between the greatest and least of those which these functions assume during the entire change. The validity of the relation between work and heat is consequently not changed by small variations in the capacities for heat. The proportional number itself is of course subject to simultaneous variations which however are smaller than the variation in the capacities.

If the gas be restored to its original volume so that at any time pdv must change its sign, the proportional number is no longer necessarily

a mean value of $\frac{\delta}{a\alpha}(c-c')$; yet we see by representing specially the heat conveyed during positive and negative work, that this number can differ but little from the values of its expression as long as the excess is not too small. If however there remains from a large amount of work only a small positive excess, it might be difficult to show that the proportional number could not differ considerably from the values of its expression.

Finally if Mariotte's law be not strictly accurate, we may put $pv+\varrho$ for pv and consider ϱ as a small magnitude depending on p and v, which at the beginning of the motion is zero. In this case in place of pdv and vdp we shall have relatively

$$pdv+\frac{d\varrho}{dv}dv\text{ ; and }vdp+\frac{d\varrho}{dp}dp.$$

The last magnitude is cancelled and does not occur in the resulting equation. On the other hand q now becomes

$$q+\int\frac{d\varrho}{dv}dv.$$

Were ϱ of the form $\psi(p)+x(v)$ the quantity added to q would $=\psi(v)$ and would vanish after the restoration to the original volume. In genral however ϱ would produce a change in the quantity of heat, which evidently would be always small, inasmuch as a sudden or quick change in ϱ is very improbable.—*Pogg. Ann.*, xcvii, 30, *Jan.*, 1856.

2. *On the crystalline form and isomeric conditions of selenium, and on the crystalline form of iodine and phosphorus.*—MITSCHERLICH has communicated to the Academy of Sciences at Berlin an interesting paper upon these subjects from which we shall extract the more important details. At its boiling point, viz. 46°·6 C., 100 parts of bisulphid of carbon dissolves 0·1 part of selenium, which separates on cooling partly in thin transparent red and brilliant scales, partly in grains which are so intensely colored that they appear opaque and almost black; thin splinters show the transparency and color of the scales. The author obtained the largest crystals by exposing the solution sealed up in a strong glass vessel alternately to a temperature somewhat lower than the boiling point of water and to that of the atmosphere. The crystals though small were very perfect and could be measured with the reflecting goniometer.

They belong to the oblique rhombic system (monoclinic) and are rich in forms. The crystals are easily soluble in the requisite quantity of bisulphid of carbon; on heating them to 150° C. they lose their bright color and become so dark as to be almost black; at the same time they become insoluble in the bisulphid, however long they may be boiled with it. When however the crystals are fused and then rapidly cooled they are completely dissolved by the bisulphid. The sp. gr. of the crystals before heating was 4·46—4·509 at 15°, after the warming 4·7. Schaffgotsch found 4·801 and the author believes the smaller number found by himself to be occasioned by small cavities in the crystals. Hittorf has observed that when amorphous or glassy selenium is heated to 90° it rapidly becomes crystalline while the temperature rises more

than 30°. The author finds that this crystallization and evolution of heat is most beautifully observed when large quantities are fused in a flask and heated to over 217° then allowed to cool down rapidly for 20° or 30° below this temperature and kept at this point for a while in an air bath. The temperature of the selenium there rapidly rises 20° or more and the whole mass becomes granular crystalline. This selenium is insoluble in bisulphid of carbon, and must be regarded as an allotropic modification. Large pieces of glassy selenium become granular-crystalline throughout when they are heated for some time in a glass tube plunged into boiling water. The external form is but slighly changed.

The insoluble selenium has a much darker color than the soluble form even when rubbed to a not very fine powder. When amorphous selenium as obtained by reducing selenium by sulphurous acid is covered with bisulphid of carbon, it is in a few weeks completely changed into crystalline selenium which is perfectly soluble in bisulphid of carbon. Glassy selenium under the same circumstances is gradually dissolved and then deposited in small crystals. From these facts the author concludes that the granular-crystalline selenium and that crystallized from a solution of selenid of sodium are identical and essentially different from that crystallized from bisulphid of carbon. Glassy selenium though amorphous belongs to the modification crystallized from the bisulphid.

The author has also obtained measurable crystals of iodine which, as Wollaston and Marchand found, belongs to the right rhombic (trimetric) system. A predominant form is the rhombic octahedron, the axes, *a*, *b*, &c. being in the ratio 1 : 2·055 : 1·505. The author's earlier investigations showed that the crystalline form of phosphorus is the regular dodecahedron. This observation is confirmed by the fact that crystals of phosphorus obtained from a solution in oil of turpentine exert no action upon polarized light and consequently can only belong to the regular system. Very beautiful crystals may be obtained by gently heating or exposing to the sunlight phosphorus contained in a glass tube either free from air or filled with a gas in which phosphorus does not oxydize. The phosphorus sublimes from one place to another and deposits itself on the cooler parts of the tube in small and brilliant crystals. Schrötter's red phosphorus presented no trace of crystalline structure.—*Journal für prakt. Chemie*, lxvi, 257.

3. *On the physical properties of chemical compounds.*—H. Kopp has published the continuation of his very valuable researches upon this subject, and we shall endeavor to present to our readers his general results though his memoirs scarcely admit of abstracts which do them justice. After a discussion of numerous particular cases the author arrives at the following conclusion in regard to the boiling points of homologous compounds in general. Homologous compounds which belong to the same series exhibit in general a difference in boiling point which is proportional to their difference in constitution. The difference in boiling points which correspond to a difference in constitution of C_2H_2 is the same in very many compounds and $=19°$. This difference however is not found in all series when the boiling points are compared at the usual mean pressure of the atmosphere; in some it is

greater, in others smaller. With respect to the specific volumes the author, after an extended historical introduction reviewing the results obtained by himself and communicated in a former paper, re-states these results in a more precise form and extends them by considering new classes of compounds. In this way it appears that in analogous compounds of the same difference of constitution we find the same difference in the specific volumes; for an x-fold difference of constitution there is an x-fold difference of spec. volume. The author illustrates this for a difference of constitution equal to $x.C_2H_2$ by citing the specific volumes of hydrocarbons, alcohols, ethers, acids of the acetic and oxalic series, aldehyds and acetones. Isomeric bodies belonging to the same type have (at their boiling points) equal specific volumes and consequently equal densities. Thus the spec. vol. of acetic acid, $C_4H_4O_4$, is 63·5, that of formate of methyl, $C_4H_4O_4$, 63·4, &c. &c. Equivalent quantities of oxygen and hydrogen may replace each other without very sensible change of volume: thus the spec. vol. of wood spirit $C_2H_4O_2$ is 41·9—42·2, that of formic acid $C_2H_2O_4$ is 40·9—41·8. It must however be remarked that the substitution of oxygen for hydrogen almost always produces a more or less perceptible change of volume. Equivalent quantities of carbon and hydrogen may replace each other without any material change in the specific volumes. Thus the spec. vol. of benzoic alcohol, $C_{14}H_8O_2$, is 123·7, that of amylic alcohol 123·6—124·4. For the spec. volumes of the elements themselves the author finds the following values; for carbon 5·5, for hydrogen 5·5, for oxygen contained within a radical 6·1, for oxygen outside of the radical 3·9. These four values may be brought together in the expression "The spec. vol. of a liquid $C_aH_bO_cO_d$ at its boiling point is $5{\cdot}5a+5{\cdot}5b+6{\cdot}1c+3{\cdot}9d$."

The symbol O is here used to denote the oxygen outside of the radical, and the author computes the spec. vols. of 45 liquids in satisfactory accordance with the observations, the difference being never 4 per cent of the whole value. The author remarks that the expression above given is simply to be regarded as a useful formula of interpolation to express the relations between the constitution and the spec. vols. of bodies. The enumeration of the specific volumes of bodies containing sulphur, chlorine, bromine and iodine leads to the following conclusions. With regard to sulphur the author remarks that this element enters into organic compounds in three different ways, (1) as replacing oxygen in compounds of the water type $\left.\begin{matrix}H\\H\end{matrix}\right\}O_2$, (2) as replacing carbon within a radical, (3) as replacing oxygen within a radical. In the first and second of these cases sulphur has the same spec. volume, namely 11·3: but when it replaces oxygen within a radical its specific volume is higher, namely, 14·3—14·4. It is remarkable that alcohol and bisulphid of carbon have the same spec. vol., viz. 62. For the compounds of chlorine the rules already laid down for combinations of oxygen, hydrogen and carbon also hold good. The spec. volume of chlorine must be taken as 22·8, which is very nearly twice that of sulphur. The spec. vol. of bromine is 27·8, and that of iodine 37·5. The author next directs his attention to the spec. volumes of inorganic compounds and points out the close correspondence between the spec. vols. of the

analogous compounds PCl_3, $SiCl_3$, $AsCl_3$, of PBr_3 and $SiBr_3$, and of $SnCl_2$ and $TiCl_2$, from which it may be inferred that tin and titanium on the one hand, and phosphorus, silicon and arsenic on the other have the same specific volumes, which for tin and titanium $=18{\cdot}7$, and for phosphorus, silicon and arsenic $=25$. Antimony has a spec. volume of 33 as deduced from both its chlorid and bromid.

The author next points out the fact that the quotient obtained by dividing the specific volume by the number of equivalents in the compound is in 44 out of the 45 liquids in his table very nearly the same, namely, from 5·1 to 5·6; water being however a remarkable exception the quotient being here 4·7. A similar result is obtained for compounds containing chlorine, bromine, iodine and sulphur, and it is further shown that between the numbers thus deduced there exists approximately at least, simple numerical relations. The difficulties however in the way of admitting these relations are very serious. In the first place the mean spec. vols. of water and of bisulphid of carbon are very different from those of other substances—the former being 4·7 and the latter 6·2; yet the accuracy of the determination is beyond a doubt precisely in these cases. On the other hand the quotients in question in consequence of the smallness of the numbers appear to correspond more closely than they really do, the variation being from 10 to 16 per cent. For these reasons the author prefers to retain the numbers which directly express the specific volumes and not those which express the mean spec. vols. The memoir is concluded by many judicious observations and interesting isolated facts for which however we must refer to the original.—*Ann. der Chemie und Pharmacie*, xcv, 1, 2 *and* 3 *Heft*, *October to December*, 1855.

4. *On the different methods of determining the weak or strong basic properties of an oxyd.* —H. Rose has published the continuation of his researches on this subject, and has obtained some valuable analytical among his various results. Of the different sesquioxyds, glucina is the only one which is dissolved by a boiling solution of sal-ammoniac. It is consequently the strongest of all the sesquioxyd bases. Alumina is easily and completely separated from lime and sesquioxyd by boiling with a solution of sal-ammoniac, a method which in principle was already employed by Deville. The same is the case with sesquioxyd of iron: in both cases however all the oxyds must be freshly precipitated and not ignited. The author next studies the behavior of the various oxyds toward a solution of chlorid of mercury. In their relations to this substance all oxyds may be divided into three classes. 1st. Those which precipitate pure yellow oxyd of mercury. 2d. Those which precipitate a red brown oxychlorid. 3d. Those which produce no precipitate. The author also gives an elaborate and able discussion of the question of the true equivalent of glucina and arrives at the conclusion that this earth must be considered as a sesquioxyd.—*Pogg. Ann.* xcvi, 436, 550.

5. *On a new class of alcohols.*—Cahours and Hofmann have identified acroleine and acrylic acid with members of the propylene series. Their investigation may be regarded as a generalization of the results obtained by Zinin, Berthelot and de Luca, with the iodid of propylene, and they have succeeded in producing what may be regarded as the

keystone of the whole edifice, namely, the alcohol of the propylene series; the authors term this body acrylic alcohol. When iodid of propylene is brought in contact with oxalate of silver, iodid of silver and oxalate of acryl are produced, the reaction being represented by the equation $AgO.C_2O_3+C_6H_5I=AgI+C_6H_5O.C_2O_3$. The new oxalate is a colorless limpid liquid boiling at 207° C.: treated with dry ammonia it yields oxamid and acrylic alcohol $C_6H_6O_2$ or C_6H_5O+HO. The alcohol is a colorless liquid having a penetrating odor recalling that of mustard and boiling at 103°. It burns with a much more luminous flame than ordinary alcohol and mixes with water in all proportions; with potassium it gives a gelatinous mass which corresponds to potassic alcohol. This last is strongly attacked by iodid of acryl (propylene), iodid of potassium being formed while a colorless liquid is set free which is the acrylic ether C_6H_5O. In the same manner the mixed ethers $C_6H_5O+C_4H_5O$ and $C_{12}H_5O+C_6H_5O$ may be obtained. By distilling acrylic alcohol with the chlorid, bromid or iodid of phosphorus, the chlorid, bromid or iodid of acryl are easily prepared. With sulphuric acid acrylic alcohol forms a sulph-acrylic acid analogous to sulphovinic acid. Phosphoric acid removes two equivalents of water from acrylic alcohol, disengaging a colorless gas which is probably C_6H_4. Oxydizing agents readily attack the new alcohol. A mixture of sulphuric acid and bichromate of potash act very violently upon it, the products being acroleine and acrylic acid. Platinum black produces the same results. Bisulphid of carbon and potash give with acrylic alcohol a compound analogous to xanthate of potash. The authors have also prepared a large number of ethers which are remarkably well defined. The cyanate of acryl mixed with ammonia gives the body $C_8H_8N_2O_2$ which is thiocinnamine in which sulphur is replaced by oxygen. Heated with water the cyanate solidifies into a mass of sinapoline or diacryl-urea $C_{14}H_{12}N_2O_2=C_2\left\{H_2.(C_6H_5)_2\right\}N_2O_2$ the reaction being represented by the equation

$$2(C_8H_5NO_2)+2HO=C_{14}H_{12}N_2O_2+2CO_2.$$

The cyanate is decomposed by boiling with a solution of potash yielding sinapoline which floats on the surface and a distillate which is a mixture of methylamine, propylamine and acrylamine. The authors conclude by pointing out the perfect parallelism between acrylic alcohol and common alcohol, and draw attention to the fact that the acryl alcohol forms the third member of a new series of alcohols represented by the general formula $C_{2n}H_{2n}O_2$. The cyanid of acryl should furnish by the action of potash an acid homologous with acrylic acid. *Comptes Rendus*, xlii, 217, *4th Feb.*, 1856.

6. *Researches on iodated propylene.*—Berthelot and de Luca have continued their observations upon this substance and have obtained in the main the same results as those of Cahours and Hofmann above described. To the body C_6H_5 they give the name of *allyl* while C. and H. use the word *acryl*. By the action of sodium upon iodid of propylene the authors obtained iodid of sodium and allyl, $C_6H_5I+Na=C_6H_5+NaI$. Allyl or acryl is a very volatile liquid, having a peculiar penetrating etherial odor. It boils at 59° C. its density at 14° is 0·684, the density of its vapor at 100° is 2·92 so that the formula C_6H_5 corre-

sponds to 2 vols., as is the case with ethyl, methyl, &c. Allyl unites directly with chlorine, bromine and iodine; the bromid and iodid have the formulas $C_6H_5Br_2$ and $C_6H_5I_2$. As the formula of the iodid of allyl $C_6H_5I_2$ differs from that of iodid of propylene by one equivalent of iodine only, the authors sought, but without success, to transform one of these bodies into the other. These facts appear to show that the two iodids do not contain the same radical and there may therefore be two isomeric bodies having the formula C_6H_5. It must be remarked however that Cahours and Hofmann give C_6H_5Br and C_6H_5I for the formulas of the bromid and iodid of acryl and that they make no distinction between propylene C_6H_5 and acryl.—*Comptes Rendus*, xlii, p. 233.

7. *Researches on tungsten.*—RICHE has obtained by the action of iodid of methyl upon metallic tungsten the iodid of a base having the formula $3(C_2H_3)W$. The iodid crystallizes from ether in large colorless plates which melt at 110° and have the formula $3(C_2H_3)W.I$. With oxyd of silver this iodid yields the corresponding oxyd as a white powder $3(C_2H_3)W.O$ which unites with acids and forms uncrystallizable salts.—*Comptes Rendus*, xlii, 205.

8. *New bases containing phosphorus.*—The discovery of basic compounds of phosphorus with methyl corresponding to methylamine, &c., is due to Paul Thenard who obtained them by passing chlorid of methyl over heated phosphuret of calcium. Cahours and Hofmann have resumed the subject and have prepared many new and interesting compounds. The authors employed in the first place the action of iodid of methyl upon phosphuret of sodium. In this manner they obtained the compounds $P(C_2H_3)_2$, $P(C_2H_3)_3$ and $P(C_2H_3)_4I$. A better method of preparing this class of bodies however consists in acting upon chlorid of phosphorus PCl_3 with zincmethyl, zincethyl, &c.; in this manner a solid mass is obtained which is a compound of chlorid of zinc with triphosphomethylamin, triphosphethylamin, &c. The reactions are

$$PCl_3+3(C_2H_3Zn)=3ZnCl+P(C_2H_3)_3$$
$$PCl_3+3(C_4H_5Zn)=3ZnCl+P(C_4H_5)_3$$
$$\text{&c.} \qquad \text{&c.}$$

When these compounds are distilled with caustic potash, liquids are obtained which have the smell of the arsenic bases and are strongly alkaline; triphosphomethylamin, triphosphethylamin &c. These bodies give with chlorhydric acid easily soluble salts which give crystallizable compounds with bichlorid of platinum. Triphosphomethylamin when heated with iodid of methyl gives a solid mass $P(C_2H_3)_4I$ which is easily soluble in alcohol and crystallizes in long needles. With the iodids of ethyl and amyl similar compounds are obtained, namely, $P(C_2H_3)_3(C_4H_5)I$, and $P(C_2H_3)_3C(_{10}H_{11})I$. The authors obtained the iodids of similar ammoniums containing amyl and ethyl in place of methyl. All of these iodids are easily decomposed by oxyd of silver and yield soluble and strongly basic oxyds. Chlorid of arsenic $AsCl_3$ yields similar compounds already known as triarsenmethylamin and triarsenethylamin. Chlorid of bismuth appears to give similar compounds though the reaction is less distinct.—*Comptes Rendus*, xli, 831.

9. *Nitrite of potash and sesquioxyd of cobalt.*—STROMEYER has carefully studied the beautiful yellow salt discovered by Fischer and some years afterward rediscovered by St. Evre. The author finds that the salt is insoluble in many saline solutions so that it may be washed with a solution of acetate of potash and afterward with alcohol; in this manner it may be used for analytical purposes. Caustic soda and baryta water easily decompose it separating a brown hydrate of sesquioxyd of cobalt. The author finds for this compound the formula

$$Co_2O_3, 2NO_3+3(KO, NO_3)+2HO$$

and explains its formation by the equation

$$2CoO, SO_3+5KO.NO_3+2HO+O=\{Co_2O_3, 2NO_3+3KO, NO_3+2HO\}+2KO.SO_3$$

When nitrite of potash is added to neutral solutions of salts of protoxyd of cobalt, no precipitate is at first produced; but the addition of a little diluted nitric or acetic acid causes an evolution of deutoxyd of nitrogen and the double nitrate is soon completely precipitated. Boiling water reduces the yellow salt completely, giving a red solution. When nitrite of potash and acetic acid are added to solutions of lead the liquid becomes yellow but there is no precipitate. The addition of a salt of cobalt produces a yellowish green, or in dilute solutions a brownish black, precipitate, which is highly crystalline and gives a yellowish green powder. The author found for this precipitate the formula

$$2(Co_2O_3 . 2NO_3)+3(KO, NO_3)+3PbO, NO_3)+4HO.$$

Ann. der Chemie und Pharmacie, xcvi, 218.

10. *On the quantitative determination of Copper.*—MOHR has suggested the use of zinc in place of iron to precipitate copper from its solutions and proceeds as follows. A copper salt containing no nitric acid is dissolved by chlorhydric acid in a porcelain crucible covered with an inverted watch-glass and pieces of distilled zinc thrown in. The copper is speedily thrown down as a spongy mass and the liquid soon becomes colorlesss, hydrogen being evolved. More zinc is to be added in case the evolution of hydrogen ceases before the color disappears. The complete precipitation of the copper is best recognized by testing a drop of the liquid with sulphydric acid water upon a porcelain plate. By stirring with a glass rod it is easy to determine whether the zinc is completely dissolved, the hard pieces of zinc being easily distinguished from the spongy copper. The clear liquid is then to be drawn off with a pipette, and a few drops of muriatic acid added to the copper which is to be gently warmed. The copper is then to be repeatedly washed in the crucible, the liquid being removed with a pipette, and finally the last portions with bibulous paper. The crucible with the copper may then be dried and weighed. The authors experiments with this method gave very satisfactory results. If the copper solution contain nitric acid, this must first be destroyed by boiling with muriatic acid avoiding a large excess.—*Ann. der Chemie und Pharmacie*, xx, 215.

[NOTE.—Zinc has long been employed in this country by assayers in the determination of copper, so that in Mohr's process nothing is new but the manipulation, which appears to be advantageous. It must

be observed, however, that the presence of lead, silver, arsenic and many other substances in copper ores would render the method inapplicable in its present form.—W. G.]

11. *On metallic Uranium.*—PELIGOT has presented to the Academy of Sciences some specimens of uranium fused at a high temperature. The author employed sodium as a reducing agent and proceeds as follows. A quantity of sodium is introduced into a porcelain crucible and covered with very dry chlorid of potassium and then with a mixture of this salt and the green chlorid of uranium. The porcelain crucible is then to be placed within one of clay, the intervening space filled with charcoal dust, and the outer crucible also covered. The crucible is then heated till the reaction takes place, which is known by the noise heard at the moment; it is then to be placed in a furnace and heated to a red-white heat for fifteen or twenty minutes. On cooling, there is found in the crucible a scoria containing globules of fused uranium. As thus prepared, the metal has a certain malleability; its color recalls that of nickel or iron. In the air it assumes a yellowish tint from superficial oxydation. Heated to redness it becomes suddenly incandescent and is covered with a black voluminous oxyd. The density of fused uranium is 18·4, and consequently after platinum (iridium?) and gold it is the heaviest body known. The author proposes to continue the study of this metal which appears to possess interesting properties.—*Comptes Rendus*, xlii, 73, *Jan.* 1856.

12. *On crystallized silicon and carbon.*—WÖHLER has found that by fusing aluminium with an excess of fluosilicate of potassium, 3KF, $2SiF_3$, in a common crucible at the melting point of silver, a gray crystalline button is obtained which by treatment with muriatic acid yields silicon in bluish metallic hexagonal scales. Deville has obtained the same modification in crystals having the tetrahedral angle 70° 31′. At a high temperature it fuses and congeals in crystals with curved faces which appear to be analogous to diamond. By the action of chlorid of carbon upon iron, Deville has obtained carbon in small hexagonal plates with metallic lustre.—*Comptes Rendus*, xlii, 48. W. G.

13. *On Ozone and Ozonic actions in Mushrooms;* by M. SCHÖNBEIN, in a letter to M. Faraday, (Phil. Mag., [4] vol. xi, p. 137, Feb. 1856.)—You know that I hold oxygen, both in its free and bound state, to be capable of existing in two allotropic modifications,—in the ozonic or active, and the ordinary or inactive condition. All the oxy-compounds yielding common oxygen at a raised temperature I consider to contain ozonized oxygen; and I am further inclined to believe that the disengagement of common oxygen from those compounds depends upon the transformation of the ozonized oxygen into the inactive one, or, to denote that allotropic change, of $\mathring{O}$ into O. Now a general fact is this: that the oxygen thus set free always contains traces of $\mathring{O}$ more or less, according to the degree of temperature at which the oxygen happens to be disengaged from those compounds. The lower that degree, the larger the quantity of $\mathring{O}$ mixed with O; though I must not omit to state, that in all cases that quantity happens to be exceedingly small in comparison to that of O obtained at the same time. The best means

of ascertaining the presence of $\mathring{O}$ is the alcoholic solution of guaiacum recently prepared. You know that O does not in the least change the color of that resiniferous liquid, whilst free $\mathring{O}$ or $PbO+\mathring{O}$, &c. has the power of coloring it deep blue. The blue matter is, as I think I have proved it, nothing but guaiacum $+\mathring{O}$. Now if you heat the purest oxyd of gold, platinum, silver, mercury, the peroxyds of manganese, lead, &c., in fact any substance yielding oxygen, within a small glass tube into which you had previously introduced a bit of filtering-paper impregnated with the said guaiacum solution, you will see that bit of paper turn blue as soon as the disengagement of oxygen begins to take place; and all the circumstances being the same, you will further perceive that the paper is colored most deeply and rapidly by the oxygen eliminated from that oxy-compound which requires the lowest temperature for yielding part or the whole of its oxygen. Thus the oxygen disengaged from the oxyds of gold, platinum and silver, acts more energetically upon the guaiacum solution than does the oxygen eliminated from the oxyd of mercury, the peroxyd of manganese, &c. I trust these results will be obtained in the Royal Institution just as well as I get them in the laboratory of Bâle, or else my discovery will be a very poor thing. As there cannot, I should think, be any doubt that all the oxygen, contained, for instance, in the oxyd of silver previously to that compound being decomposed by heat, exists but in one state, be that state what it may, how then does it happen, we may ask, that at the same time two different sorts of oxygen, O and $\mathring{O}$, are disengaged from the compound named? The answer to this question seems to me to be, that one of the two kinds of oxygen eliminated must be engendered at the expense of the other; or to speak more correctly, that during the act of elimination of oxygen from the oxyd of silver, part of that oxygen suffers a change of condition. Now as the oxyds of gold, silver, &c., enjoy the power of coloring blue the guaiacum solution, just as free $\mathring{O}$ does, I draw from the fact the conclusion, that the condition of the oxygen contained in the oxyds of gold, silver, &c. is the ozonic one; and further infer, that by far the greatest portion of that $\mathring{O}$, under the influence of heat, is transformed into O. Why the whole of the oxygen disengaged from those oxyds does not happen to be O, I certainly cannot tell, but I think that the very fact of the mixed nature of the oxygen in question is, in a theoretical point of view, highly important, and speaks in favor of my notions rather than against them.

Although I have already heavily taxed your patience, I am afraid I cannot yet release you from further listening to my philosophical talkings, for I have still to speak of a subject that has of late deeply excited my scientific curiosity, and taken up all my leisure time. But to give you an idea of what I have been doing these last two months, I must be allowed prefacing a little. You know that I entertain a sort of innate dislike to touch anything in the slightest way connected with organic chemistry, knowing too well the difficulty of the subject and the weakness of my power to grapple with it; but in spite of this well-grounded disinclination, I have of late, and, as it were, by mere chance,

been carried into the midst of that field, upon the intricacies and depths of which I have been used all my life to look with feelings of unbounded respect and even awe. The picking up of a mushroom has led to that very strange aberration of mine, and you will ask how such a trifling occurrence could do that. The matter stands thus: what the botanists tell me to be called "*Boletus luridus*," with some other sorts of mushroom, have the remarkable property of turning rapidly blue when their head and stem happen to be broken and exposed to the action of the atmospheric air. On one of my ramblings I found a specimen of the said *Boletus*, perceived the change of color alluded to, and being struck with the curious phenomenon, took the bold resolution to ascertain, if possible its proximate cause. I carried home the part, set to work, and found more than I looked for, which luckily enough happens now and then. Being, by the short space allotted even to the longest letter, prevented from entering into the details of the subject, I confine myself to stating the principal results obtained from my mushroom researches. *Boletus luridus* contains a colorless principle, easily soluble in alcohol; and in its relations to oxygen, bearing the closest resemblance to guaiacum, as appears from the fact, that all the oxydizing agents which have the power of bluing the alcoholic solution of guaiacum, also enjoy the property of coloring blue the alcoholic solution of our mushroom principle; and all the deoxydizing substances by which the blue solution of guaiacum is decolorized also discharge the color of the blued solution of the *Boletus* matter. From this fact and others, I infer that this mushroom principle, like guaiacum, is capable of combining with $\mathring{O}$, and is not affected by O. Now the occurrence of a matter so closely related to guaiacum in a mushroom is a fact pretty enough of itself, but as to scientific importance far inferior to what I am going to tell you.

The fact that the resinous *Boletus* principle, after having been removed from the mushroom (by means of alcohol), is not able to color itself spontaneously in the atmospheric air, whilst it seems to have that power so long as it happens to be deposited in the parenchyma of the *Boletus*, led me to suspect that there exists in the *Boletus luridus*, besides the guaiacum-like substance, another matter, endowed with the property of exalting the chemical power of common oxygen, and causing that element in its $\mathring{O}$ condition to associate itself to the resinous principle of the mushroom. The conjecture was correct; for I found that in the juice obtained by pressure from a number of mushrooms belonging to the genera *Boletus* and *Agaricus*, and notably from *Agaricus sanguineus* (upon which I principally worked), an organic matter is contained which enjoys the remarkable power of transforming O into $\mathring{O}$, and forming with the latter a compound from which $\mathring{O}$ may easily be transferred to a number of oxydable matters, both of an inorganic and organic nature; and I must not omit to state, that the peculiar Agaricus matter, after having been deprived of its $\mathring{O}$, may be charged with it again by passing through its solution a current of air. The easiest way of ascertaining the presence of $\mathring{O}$ in the said Agaricus juice, is to mix that liquid with an alcoholic solution of guaiacum, or

the resinous matter of the *Boletus luridus*. If the juice happens to be deprived of $\mathring{O}$, the resiniferous solutions will not be colored blue; but if it contains $\mathring{O}$, the solution will assume a blue color, just as if they were treated with peroxyd of lead, permanganic acid, hyponitric acid, &c. From the facts stated, it appears that the organic matter in question is a true carrier of oxygen, and therefore, when charged with it, an oxydizing agent. Indeed, that matter may in many respects be compared to NO^2, which, as is well known, enjoys to an extraordinary extent the power of instantaneously transforming O into $\mathring{O}$, and forming a compound ($NO^2+2\mathring{O}$) with that $\mathring{O}$, from which the latter may easily be transfered to a multitude of oxydable matters. Now in a physiological point of view, the existence of such an organic substance is certainly an important fact, and seems to confirm an old opinion of mine, according to which the oxydizing effects of the atmospheric oxygen (of itself inactive) produced upon organic bodies, such as blood, &c., are brought about by means of substances having the power both of exciting and carrying oxygen.

Before dropping this subject, I must not omit to mention a fact or two more. The peculiar matter contained in the juice of the *Agaricus sanguineus*, &c., and charged with $\mathring{O}$, gives up that oxygen to guaiacum, and the latter transfers it to the resinous matter of the *Boletus luridus*; thus the different organic matters capable of uniting with $\mathring{O}$ as such, exhibit different affinities for that oxygen, a fact not without physiological importance. Another fact worthy of remark, is the facility with which the nature of our Agaricus matter may be changed. On heating the aqueous solution to the boiling-point, it not only loses the property, but also the capacity of again becoming an oxydizing agent, i. e. carrier of oxygen, however long it may be kept in contact with atmospheric air. I am very sorry to be prevented from entering more fully into the details of the subject, but from the little I have said about it you may easily understand why this mushroom affair has of late so much engaged my attention.

II. Geology.

1. *Description of two Icthyodorulites*, by Joseph Leidy, M.D., (Proc. Acad. Nat. Sci. Philad. vol. viii, p. 11.)—Stenacanthus nitidus, Leidy. The species of a genus supposed to be distinct from those which have been described, is indicated by an icthyodorulite, discovered by Charles E. Smith, Esq., in association with the remains of *Holoptychius*, in the old Red Sandstone formation of Tioga county, Pennsylvania. The specimen is partially imbedded in a mass of red sandstone; and it has its points broken of and is otherwise mutilated. The spine is straight throughout and indicates no disposition to curve. In its perfect condition it appears to have been about three inches in length, by about six lines in breadth at its base; and it gradually tapers towards the apex. The anterior margin is convex. The posterior border at the edge of the exposed surface of the fossil is furnished with a row of closely set serrations, directed obliquely downward, of which eight may be counted

within the space of seven lines. Whether there is a second row of serrations, the imbedded state of the very friable bone in a hard matrix will not permit me to determine.

The broad surface which is exposed in the specimen, so far as it is preserved, is longitudinally furrowed; and about three-fourths of an inch from the broken summit it exhibits a transverse zigzag fissure, which may probably be the result of an original fracture, although it has very much the appearance of being an articulation.

CYLINDRACANTHUS ORNATUS, Leidy.—On several occasions fragments of apparent fossil bones have been submitted to my inspection, the character of which has exceedingly puzzled me, and although I now view them as portions of ichthyodorulites, I am not positive of the correctness of my conclusion. The specimens alluded to are found in the cretaceous formations of New Jersey and Alabama. The most perfect one was obtained by W. Taylor, Esq., from near Pemberton, Burlington Co., New Jersey. It is over three inches in length with the extremities broken off, is straight and gradually tapering, and is perfectly circular in transverse section. At the thicker end it is six and one quarter lines in diameter, and at the other end five lines. The centre presents a double tubular perforation of comparatively small calibre. The surface is invested with a thick, enamel-like layer, which is dense, brittle, and shining, and deeply fluted; the intervening ridges being of nearly uniform diameter, with pairs occasionally converging into single ones in their course.

2. *Notices of some remains of extinct Mammalia, recently discovered by Dr. F. V. Hayden, in the bad lands of Nebraska;* by JOSEPH LEIDY, M.D., (Ibid, p. 59.)—(1.) HIPPARION OCCIDENTALE, *Leidy.*—This second American species of *Hipparion* is established on specimens of five superior and one inferior molar teeth, discovered by Dr. Hayden, on the White River of Nebraska. The internal isolated enamel column of the upper molars, on the worn crown, is elliptical and more than twice the length of the breadth. The central columns of the same teeth are comparatively moderately folded. Antero-posterior diameter of the first upper molar 15 lines, transverse diameter 10½ lines; antero-posterior diameter of the largest of the back upper molars 13 lines, transverse diameter 12 lines; smallest of the back upper molars 11 lines square; antero-posterior diameter of the back inferior molar 12 lines, transverse diameter 7½ lines.

(2.) HYOPOTAMUS AMERICANUS, *Leidy.*—This species is founded upon a number of specimens of molar teeth, which were discovered by Dr. Hayden, in company with remains of *Titanotherium*, in Nebraska Territory. The teeth indicate a species of the same size as *Hyopotamus bovinus*, Owen. Among the specimens are the posterior two upper molars of both sides of the jaw from the same individual; and they present almost a repetition of form of the homologous pair of *H. vectianus*, Owen. The collection also contains two premolars in conjunction, apparently from the same individual as the true molar just mentioned. They correspond to the second and third premolars of *Anthracotherium:* the crown of the second premolar consisting of a single large trihedral lobe, with a tubercle at its postero-internal basal angle; and the crown of the third premolar being formed of a trans-

verse pair of lobes, of which the outer one is trihedral and the inner one is smaller and conical. These premolars undoubtedly belong to the permanent dentition, and if they are not the second and third of the series, they are certainly the latter and the fourth. In either case, they confirm an opinion formerly expressed (Anc. Fauna of Nebraska, p. 45,) that the teeth represented by Prof. Owen, as the third and fourth permanent premolars of *Hyopotamus vectianus*, (Lond. Quart. Journ. of the Geol. Soc., pl. vii, vol. iv,) really belong to the deciduous dentition; and therefore, although *Hyopotamus* may not be identical with *Anthracotherium*, it is much more nearly allied to it than was suspected by its distinguished author.

The measurements of some of the molar teeth of *Hyopotamus americanus* are as follows:

Antero-posterior diameter of the superior last true molar, externally,	13½ lines.
Transverse " " " anteriorly,	15 "
Antero-posterior diameter of the superior third premolar,	6 "
Transverse " " "	8¾ "
Antero-posterior diameter of the superior second premolar,	10½ "
Transverse " " "	8½ "

3. *Second Annual Report of the Geological Survey of the State of New Jersey, for the year* 1855. 248 pp., 8vo. Trenton: 1856.—This second Annual Report on the Geology of New Jersey, contains a Report on the Topographical Department of the State by E. L. Viele, State Topographical Engineer, on the Geology of the northern division of the State by Wm. Kitchell, Superintendent and State Geologist, and on the Geology of the southern division of the State by George H. Cook, Assistant Geologist. A good beginning has been made towards developing the structure and beds of the Cretaceous formation, a brief mention of which as made out the preceding year being given in vol. xix of this Journal, page 438. The observations are farther extended in this Report by local details: but the characteristic fossils of the beds remain to be catalogued. Mr. Cook observes that passing southeast from the Red Sandstone region, the first, or lowest beds reached are light colored clays, including fire and potter's clays, then black and chocolate colored astringent clays; then the several beds of greensand marl with intermediate beds of marl, and lastly the more recent beds of shell marl, sand, clay and gravel which make up the southeastern part of the State.

Evidences of wear and subsidence along the New Jersey coast are mentioned on pages 78—81, which merit a full investigation. We cite the following paragraphs:—

During the past season, while in the southern part of the State, my attention was frequently called to the rapid wearing away of the shores, and to the advance of the tide-waters on the land. Local causes were generally assigned for the increased height of the tides; but this and other phenomena were extended over so long a line of shore, that it was thought there must be some general cause for them; and this cause appears to be, the slow but continued settling or subsidence of the land.

At the mouth of Dennis creek, in Cape May county, and for several miles along the bay-shore, on each side of it, according to the local

surveyors, the marsh wears away, on an average, about one rod in two years; and, from the early maps, it would appear to have been going on at that rate ever since the first settlement of the country. A map of Cape May, in the possession of Dr. Maurice Beesley, of Dennisville, and bearing the date of 1694, lays down Egg Island, the western point of Maurice River Cove, as containing 300 acres; at low water it now contains a half or three-fourths of an acre, and at high water it is entirely covered. All along the Delaware Bay and river where the marshes are banked in to keep off the tide, the banks or dykes are placed several rods from the water's edge, to allow for the wearing away of the marsh.

At Town Bank, which is the principal bold shore on the west side of Cape May, and where the first settlement was made as early as 1691, the solid gravel bank, which is from twelve to eighteen feet high, wears away, according to the owner, Mr. Thomas Hughes, about one foot a year. The foundations of the houses first built were long since undermined, and the waters of the bay now occupy the spot where they originally stood. At Cape Island, on the Atlantic shore, the wear is equally rapid, a full mile having been worn in since 1780, as I am informed by Mr. Ezekiel Stevens. During the war of that period a militia artillery company had its practicing ground here. Their gun was placed near a house which stood just outside the present shore line, and their target was set up three quarters of a mile east. This last point was at the outer edge of the cultivated ground, and there was a quarter of a mile of sand hills or *beaches* between that and the water's edge. The whole of this is now gone, and one of the boarding houses has been moved back twice, on account of the wearing away of the bank. The sand beaches on the Atlantic shore are drifting in every year. Dr. Leaming says that Ludlam's Beach, opposite his residence, has moved inward fully one hundred yards during the last twenty years; and that the salt marsh sods which formed west of the beach are now seen on the strand east of it.

That the tides rise higher upon the uplands than formerly, is the opinion of the oldest observers, upon the Atlantic and Bay shores, from Great Egg Harbor quite around to Salem creek. Their opinion is founded on the fact, that on the low uplands, or those going down to the salt marsh with a very gentle slope, the salt grass now grows where upland grass formerly grew; and where the land was in wood, narrow fringes of it next the marsh are frequently killed by the salt water, and marsh takes its place. Hon. Joshua Brick, of Port Elizabeth, estimates the amount of timbered land between Maurice river and West creek, in Cumberland County, which has been killed within the last fifty years, at one thousand acres. And the amount is proportionally great on all the low and wooded shores. Numerous *islands* (spots of hard ground surrounded by salt marsh) which, within the memory of men now living, have been cultivated, and others which were in wood, have been entirely lost in the advancing marsh, and their location is only to be known by the shallowness of the mud which covers them.

In all the salt marshes on the sea shore of southern New Jersey, and also in the salt and fresh tide marshes on Delaware Bay and river, stumps of trees, of the common species of the country, are found with

their roots still fast in the solid ground at the bottom of the marsh, and this at depths far below low-water mark. A reference to localities for these is not necessary. The fact is known to every one living in the neighborhood of these marshes, and the evidence of it can be seen in the bottoms or in the banks of almost every ditch that is cut in them.

The time during which this settling has been going on cannot be estimated with any degree of accuracy. But some idea of it may be obtained by noticing the phenomena of the cedar swamps where buried timber is dug or *mined*. In these swamps, and in the salt marshes near them, underneath the standing trees, or under the stumps in the marsh, cedar logs are found buried—and these one under the other, in such numbers, and so sound, that they are valuable for timber. By sounding with an iron rod, these logs can be felt under the surface at all depths, from one to ten feet, and some have said for even more than this. At Dennisville a well was dug in the marsh eleven feet in depth. The mud near the surface was the common blue mud of the marshes; at a small depth the peaty cedar swamp earth was reached, and in it cedar timber, logs, and stumps, were found for several feet, and near the bottom the sweet gum (*Liquidambar styracifolia*,) and the spoon-wood or magnolia (*Magnolia glauca*,) were found. The well reached hard bottom. The white cedar grows on peat, and its roots run near the surface, so that it might be supposed the mud had settled with them, were it not for the fact that, when cedar grows where the mud is shallow, so that its roots reach hard bottom, its wood is unfit for timber, the grain or fibres being so interlocked that it will not split freely. Such is found to be the case in the buried timber; the bottom layer, as it is called, is worthless. From this the inference is conclusive that the hard ground was above tide level when those trees grew. Large stumps are frequently found standing directly on other large logs, and with their roots growing all around them, and then other logs still under these, so that one soon becomes perplexed in trying to count back to the time when the lower ones were growing. Dr. Beesley, of Dennisville, some years since communicated to the newspapers an article on the age of the cedar swamps, which was copied by Mr. Lyell in his Travels in the United States, Second Visit, vol. i, p. 34; in which Dr. B. says that he "counted 1080 rings of annual growth between the centre and outside of a large stump six feet in diameter, and under it lay a prostrate tree, which had fallen and been buried before the tree to which the stump belonged first sprouted. This lower trunk was five hundred years old, so that upward of fifteen centuries were thus determined, beyond the shadow of a doubt, as the age of one small portion of a bog, the depth of which is as yet unknown."

Mr. Thomas Shourds, of Hancock's Bridge, Salem County, informed me that the sluices in a meadow bank near his residence, on Alloways Creek, were fully three feet below low-water mark—so low, indeed, that within thirty years he has seen them but twice. The bank was built about the year 1700. Sluices are usually made in marsh earth, but it is said they do not settle much. And, in this instance, there is good reason to believe they are properly placed for what the tide must have been when they were set. On the opposite bank of the creek from these sluices there is an oak stump standing, the roots of which

are in the solid bottom, and the top of it is about the level of high tide. The top is square, as if cut off by an axe, and the longest time since it was cut can be little more than one hundred and fifty years. And when alive it must have been not less than three feet higher than now, to be out of the way of the tide. Judge Brick, of Port Elizabeth, says the tides have advanced a foot within fifty years—which, it will be perceived, agrees with the evidence to be obtained from the stump.

Many persons have been disposed to estimate the rate of subsidence higher than this—but, in general, the statements are rather from impressions than from any fixed marks to refer to. I am confident, however, that two feet in a hundred years, is not above the rate at which the shore is now sinking. * * * * * *

From some facts collected, it would appear that the change on our own shore, is not confined to southern New Jersey. In the salt marshes on the Raritan, between New Brunswick and Perth Amboy, buried wood and stumps are common. Some years since a canal was dug across the marsh, from Washington to French's landing, to cut off some of the bends in South river, and the Raritan. The marsh cut through was from one to four feet deep, with a sandy bottom. Hundreds of stumps of the common yellow pine of the country, were found with their roots still firm in the sand as they grew; and though most of them were removed, a few are still to be seen at low water. The general impression at Washington is that the tides are fuller now than formerly. The marshes at the mouths of the Passaic and Hackensack are well known to contain great quantities of buried timber, and it is but a few years since they were covered with cedar trees. The same is true of the marshes on the shore of Long Island. Prof. Hitchcock, in his report on the Geology of Massachusetts, gives accounts of buried wood, erect stumps and peat, being found in the sea, at or below low-water mark, as at the harbor of Nantucket, at Holmes Hole, on Martha's Vineyard, and also near the southwest extremity of the same island. They are seen too on the north side of Cape Cod, also opposite Yarmouth, and in Provincetown bay. Mr. Lyell, in his second visit to the United States, mentions a submerged forest "at Hampton, on the way from Boston to Portsmouth," also one near Portsmouth, N. H., "now submerged at low water, containing the roots and upright stools of the white cedar, showing that an ancient forest must once have extended farther seaward." In his First Visit to North America, vol. ii, p. 143, he mentions a submerged forest somewhat similar near Fort Cumberland, in Nova Scotia. In the same work, vol. i, p. 131, in speaking of the coast of Georgia, he says, "I even suspect that this coast is now sinking down at a slow and insensible rate, for the sea is encroaching and gaining at many points on the fresh water marshes. Thus at Beauly, I found upright stumps of trees of the pine, cedar and ilex, covered with live oysters and barnacles, and exposed at low tides; the deposit in which they were buried having been recently washed away from around them by the waves." He records other observations in relation to the submerged trees at the mouth of Cooper river, near Charleston, and of the Altamaha, in Georgia. He quotes Bartram, the botanist, who wrote in 1792, as saying, "It seems evident even to demonstration, that those salt marshes adjoining the coast of

the main, and the reedy and grassy islands in the rivers, which are now overflowed at every tide, were formerly high swamps of firm land, affording forests of cypress, tupelo, Magnolia grandiflora, oak, ash, sweet bay, and other timber trees, the same as are now growing on the river swamps, whose surface is two feet or more above the spring tides that flow at this day. And it is plainly to be seen by every planter along the coast of Carolina, Georgia and Florida, to the Mississippi, when they bank in these grassy tide marshes for cultivation, that they cannot sink their drains above three or four feet below the surface, before they come to a strata of cypress stumps, and other trees, close together as they now grow in the swamps."

Analyses are given of various clays—one of a South Amboy fire clay which is used for facing paper-hangings, others of pottery clays, &c.

Prof. Kitchell describes the crystalline rocks which prevail in the northern portion of the state (incorrectly called Azoic, as they are not of the Azoic age, although without fossils in consequence of metamorphic action), and gives many valuable details respecting the mines of copper, zinc, and iron. To this portion of the volume there are contributions from the results of Mr. Wurtz, the chemist to the survey, relating to the mines and their ores and other minerals. The mineralogical facts we propose to cite from, at another time.

The volume is illustrated by many beautiful engravings of scenery, representing landscapes in New Jersey, its lakes, mines, cedar swamps, etc.; and there are also some woodcuts, a map relating to the triangulation of the state, and another map of one of the mining regions.

4. *Geological Survey of Missouri.*—The first and second Annual Reports of the Geological Survey of Missouri, were announced in a former number as issued in a single octavo volume by the state geologist, Prof. G. C. Swallow, under the auspices of the legislature. We mention the reports again, to express our high estimate of the volume, and our earnest hope that a work so well begun may be carried on to its end. They are only the *annual* reports, not the final work; and we are free to say that none of the annual reports of our various surveys have come out in a manner more creditable to the authors or state, none in fact have equalled it in style of publication and illustrations. Some points no doubt remain for correction through future investigations, as happens in all such unfinished surveys, but, with few exceptions, the results appear to be carefully obtained as far as we can judge without going over the ground itself, and with judicious attention to points of geological interest, as well as to the best welfare of the state. The vast mines of iron, and those of lead, copper, and zinc, present the strongest inducements to a continuation of the work, regarding only its economical importance.

Prof. Swallow is aided in the survey by Dr. Litton, as chemist, who has in the volume a valuable report on the mines, with numerous analyses of ores and limestones; also by Dr. Meek, Mr. Hawn, and Dr. Shumard in the geology and palæontology.

5. *Pseudomorph of Smithsonite.*—We are informed by Mr. W. J. Taylor of Philadelphia, that he has observed at the Lancaster zinc mines, Pennsylvania, beautiful pseudomorphs of Smithsonite having the form of dolomite.

III. Botany and Zoology.

1. *For what purpose were plants created?* (addressed to Prof. Dana.) —Plants furnish all the food upon which animals live. Plants, by decomposing carbonic acid, &c., purify the air which animals breathe. In which of these offices may we say that the vegetable kingdom fulfills its essential purpose? In your admirable exposure of the character and tendency of Prof. Tayler Lewis's work, you take the view that the essential object of the vegetable creation is to purify the atmosphere for the breathing of animals, and assert that its use in providing food for animals is only incidental, or 'concomitant.'

May I venture to question this; and to remark that I have been accustomed to consider the opposite view as the more correct and philosophical. I think also that it would answer equally well the purpose of your argument. It is just because that general argument is so sound and able, and because it proceeds from such very high scientific authority, that I am induced to call your attention to this questionable point, not without the hope that you may see cause to correct or qualify the statement.

That the office of plants in the economy of the world is, not so much to purify the air for animals, as to supply them nourishment, may be argued,

1st. From the nature of the operation in which oxygen gas is liberated by vegetables. Plants take carbonic acid, water, &c., from the air, and decompose them, giving back to the atmosphere a part of the oxygen, while they transform the rest of the materials into vegetable fabric, or into vegetable products (mostly the prepared materials of vegetable fabric). The raw materials used contain more oxygen than the vegetable matter produced from them does. The surplus oxygen has to be eliminated, and is therefore given off in a free state. Which appears to be the essential thing here:—the formation of vegetable fabric, or of organic matter, by which alone the plant can grow, from its parts, and continue to exist; or the evolution of the oxygen gas necessarily separated in the process, and which has to be got rid of?

It is in this *deoxydizing* and *organizing* operation, no doabt, that the essence of vegetation consists: but, that the great purpose is the *organization*, rather than the elimination of oxygen, and that the uses the latter may subserve (however important) are only contingent or 'concomitant,' may be further inferred,

2d. From considering the kind and the degree of the dependence of the animal creation upon these two results of vegetation, namely, the vegetable matter produced, and the oxygen gas liberated. Now, upon the first, as is well known, the dependence of the animal creation is *entire* and *absolute:* upon the second only *remote* and *contingent.* For vegetable matter, so produced furnishes the whole food and fabric of animals. Without it animal life could not have existed at all; and were its production now to be suspended, all the herbivorous and then the carnivorous races would perish almost at once. On the other hand, the amount of the dependence of animal life upon the disengagement

of oxygen gas by plants may be estimated by supposing existing vegetation to cease evolving free oxygen, or (which would come to the same thing) by supposing some new operation in the organic world to absorb this element as fast as it is given to the air by plants. How soon would the diminution of the oxygen of the air be felt even by the higher classes of animals. Making the needful calculations, M. Dumas has answered this question, by assuring us that the unbalanced action of the whole animal kingdom for a century would not consume more than $\frac{1}{5000}$ part by weight of the oxygen of the atmosphere;—"a quantity altogether inappreciable to the most delicate means of investigation we possess at the present day, and which very certainly would have no influence on the life of animals,"—that, as respects the higher races of animals, "it would require no less than 10,000 years before all the men on the face of the globe could produce an effect which should be sensible to Volta's Eudiometer, even supposing vegetable life to be extinct during the whole of this time;"—so vast is the original stock of this important element of the atmosphere.

Surely, then, we ought not to call this remotely needful action upon the air the *essential* office of vegetables in the economy of the world, nor view as a subordinate or concomitant end that operation of organizing matter, which provides the whole animal creation with sustenance, and the failure of which for a single year would depopulate the earth. Nor should we call that the essential office of vegetation which certainly was not essential (as the other *was*) to the existence of an abundant animal life before and during the epoch of the coal-formation, and which (however propitious) has not been proved to be *necessary* even to the existence of man.

Of course there is no question here of this as a function of vegetation, and of the reciprocal action of the two kinds of organized beings upon the air, as maintaining the balance of its elements; but even here it is not always considered that, as Sir Boyle Roche once said, "the reciprocity is all on one side;"—that though the animal kingdom could not exist at all without the vegetable, yet the vegetable kingdom might very well exist and flourish without the animal.

In other words, the vegetable creation is a provision for the animal, immediately and continually essential in one respect,—remotely and contingently needful—possibly essential to its *well-being*, but not to its *being*,—in the other. A. G.

Additional Note by J. D. Dana.—My meaning was this, that the whole structure and physiology of the plant was based on the great fact referred to, or its mode of living; and that this principle therefore, rather than the purpose of feeding animals, was that which in a sense determined the structure in this kingdom of life.

2. *Researches on the Foraminifera: Part I, General Introduction, and Monograph of the genus Orbitolites;* by WILLIAM B. CARPENTER, M.D., F.R.S., F.G.S., &c., (Ann. Mag. Nat. History, vol. xvi, p. 207.)—The group of *Foraminifera* being one as to the structure and physiology of which our knowledge is confessedly very imperfect, and for the natural classification of which there is consequently no safe basis, the author has undertaken a careful study of some of its chief typical forms, in order to elucidate (so far as may be possible) their

history as living beings, and to determine the value of the characters which they present to the systematist. In the present memoir, he details the structure of one of the lowest of these types, *Orbitolites*, with great minuteness; his object having been, not merely to present the *results* of his investigations, but also to exhibit the *method* by which they have been attained; that method essentially consisting in the minute examination and comparison of a *large number* of specimens.

The *Orbitolite* has been chiefly known, until recently, through the abundance of its *fossil* remains in the Eocene beds of the Paris basin; but the author, having been fortunate enough to obtain an extensive series of *recent* specimens, chiefly from the coast of Australia, has applied himself rather to these as his sources of information; especially as the *animals* of some of them have been sufficiently well preserved by immersion in spirits, to permit their characters to be well made out.

As might have been anticipated from our knowledge of their congeners, these animals belong to the *Rhizopodous* type; the soft body consisting of *sarcode*, without digestive cavity or organs of any kind; and being made up of a number of segments, equal and similar to each other, which are arranged in concentric zones round a central nucleus. This body is invested by a calcareous shell, in the substance of which no minute structure can be discerned, but which has the form of a circular disk, marked on the surface by concentric zones of closed cells, and having minute pores at the margin. Starting from the central nucleus,—which consists of a pear-shaped mass of sarcode, nearly surrounded by a larger mass connected with it by a peduncle,—the development of the Orbitolite may take place either upon a *simple*, or upon a *complex* type. In the former (which is indicated by the *circular* or *oval* form of the cells which show themselves at the surfaces of the disk, and by the *singleness* of the row of marginal pores), each zone consists of but a single layer of segments, connected together by a single annular stolon of sarcode; and the nucleus connected with the first zone, and each zone with that which surrounds it, by radiating peduncles proceeding from this annulus, which, when issuing from the peripheral zone, will pass outwards through the marginal pores, probably in the form of *pseudopodia*. In the *complex* type, on the other hand (which is indicated by the *narrow* and *straight-sided* form of the superficial cells, and by the *multiplication* of the horizontal rows of marginal pores), the segments of the concentric zones are elongated into vertical columns with imperfect constrictions at intervals; instead of a single annular stolon, there are two, one at either end of these columns, between which, moreover, there are usually other lateral communications; whilst the radiating peduncles, which connect one zone with another, are also multiplied, so as to lie in several planes. Moreover, between each annular stolon and the neighboring surface of the disk, there is a layer of superficial segments, distinct from the vertical columns, but connected with the annular stolons; these occupy the narrow elongated cells just mentioned, which constitute two *superficial* layers in the disks of this type, between which is the *intermediate* layer occupied by the columnar segments.

These two types seem to be so completely dissimilar, that they could scarcely have been supposed to belong to the same species; but the examination of a large number of specimens shows, that although one is often developed to a considerable size upon the simple type, whilst another commences even from the centre upon the complex type, yet that many individuals which begin life, and form an indefinite number of annuli, upon the simple type, then take on the more complex mode of development.

The author then points out what may be gathered from observation and from deduction respecting the *Nutrition* and mode of *Growth* of these creatures. He shows that the former is probably accomplished, as in other Rhizopods, by the entanglement and drawing in of minute vegetable particles, through the instrumentality of the pseudopodia; and that the addition of new zones probably takes place by the extension of the sarcode through the marginal pores, so as to form a complete annulus, thickened at intervals into segments, and narrowed between these into connecting stolons, the shell being probably produced by the calcification of their outer portions. And this view he supports by the results of the examination of a number of specimens, in which *reparation of injuries* has taken place. Regarding the *Reproduction* of Orbitolites, he is only able to suggest that certain minute spherical masses of sarcode, with which some of the cells are filled, may be *gemmules;* and that other bodies, enclosed in firm envelops, which he has more rarely met with, but which seem to break their way out of the superficial cells, may be *ova*. But on this part of the inquiry, nothing save observation of the animals in their living state can give satisfactory results.

The regular type of structure just described is subject to numerous *variations*, into a minute description of which the author next enters; the general results being, that neither the shape nor dimensions of the entire disk, the size of the nucleus or of the cells forming the concentric zones, the surface-markings indicating the shape of the superficial cells, nor the early mode of growth (which, though typically *cyclical* sometimes approximates to a *spiral*), can serve as distinctive characters of *species;* since, whilst they are all found to present most remarkable differences, these differences, being strictly gradational, can only be considered as distinguishing *individuals*. It thus follows that a very wide *range of variation* exists in this type; so that numerous forms which would be unhesitatingly accounted specifically different, if only *the most divergent examples* were brought into comparison, are found, by the discovery of those *intermediate links* which a large collection can alone supply, to belong to one and the same specific type.

After noticing some curious *monstrosities*, resulting from an unusual outgrowth of the central nucleus, the author proceeds to inquire into the *essential character* of the Orbitolite, and its relations to other types of structure. He places it among the very lowest forms of Foraminifera; and considers that it approximates closely to sponges, some of which have skeletons not very unlike the calcareous net-work which intervenes between its fleshy segments. Of the *species* which the genus has been reputed to include, he states that a large proportion

really belong to the genus *Orbitoides*, whilst others are but varieties of the ordinary type. This last is the light in which he would regard the *Orbitolites complanata* of the Paris basin; which differs from the fully-developed Orbitolite of the Australian coast in some very peculiar features (marking a less complete evolution), which are occasionally met with among recent forms, and which are sometimes distinctly transitional towards the perfect type.

The author concludes by calling attention to some general principles, which arise out of the present inquiry, but which are applicable to all departments of Natural History, regarding the *kind* and *extent* of comparison on which alone specific distinctions can be securely based.

3. *Notes on British Foraminifera;* by J. Gwyn Jeffreys, Esq., F.R.S. (Ib., p. 209)—Having, during a great many years, directed my attention to the Foraminifera which inhabit our own shores, I venture to offer a few observations on this curious group, as Dr. Carpenter, who has favored the Society with an interesting and valuable memoir on the subject, seems not to have had many opportunities of studying the animals in the recent state.

Rather more than twenty years ago I communicated to the Linnæan Society a paper on the subject, containing a diagnosis and figures of all the species. This paper was read and ordered to be printed in the Transactions of that Society; but it was withdrawn by me before publication, in consequence of my being dissatisfied with D'Orbigny's theory (which I had erroneously adopted), that the animals belonged to the Cephalopoda; and my subsequent observations were confirmed by the theory of Dujardin. I have since placed all my drawings and specimens at the disposal of Mr. Williamson of Manchester, who has given such a good earnest of what he can do in elucidating the natural history of this group, by his papers on *Lagena* and the Foraminiferous mud of the Levant.

The observations which I have made on many hundred recent and living specimens of various species, fully confirm Dr. Carpenter's view as to the simple and homogeneous nature of the animal. His idea of their reproduction by gemmation is also probably correct; although I cannot agree with him in considering the granules which are occasionally found in the cells as ova. These bodies I have frequently noticed, and especially in the *Lagenæ;* but they appeared to constitute the entire mass, and not merely a part of the animal. I am inclined to think they are only desiccated portions of the animal, separated from each other in consequence of the absence of any muscular or nervous structure. It may also be questionable if the term "ova" is rightly applicable to an animal which has no distinct organs of any kind. Possibly the fry may pass through a metamorphosis, as in the case of the Medusæ.

Most of the Foraminifera are free, or only adhere by their pseudopodia to foreign substances. Such are the *Lagena* of Walker, *Nodosaria*, *Vorticialis* and *Textularia*, and the *Miliola* of Lamarck. The latter has some, although a very limited, power of locomotion; which is effected by exserting its pseudopodia to their full length, attaching itself by them to a piece of seaweed, and then contracting them like india-rubber, so as to draw the shell along with them. Some of the

acephalous mollusks do the same by means of their byssus. This mode of progression is, however, exceedingly slow; and I have never seen, in the course of twenty-four hours, a longer journey than a quarter of an inch accomplished by a *Miliola*, so that in comparison with it, a snail travels at railroad pace.

Some are fixed or sessile, but not cemented at their base like the testaceous annelids. The only mode of attachment appears to be a thin film of sarcose. The *Lobatula* of Fleming, and the *Rosalia* and *Planorbulina* of D'Orbigny belong to this division.

Dr. Carpenter considers the Foraminifera to be phytophagous, in consequence of his having detected in some specimens, by the aid of the microscope, fragments of *Diatomaceæ* and other simple forms of vegetable life. But as I have dredged them alive at a depth of 108 fathoms (which is far below the Laminarian zone), and they are extremely abundant at from 40 to 70 fathoms, ten miles from land and beyond the range of any seaweed, it may be assumed without much difficulty, that many, if not most of them, are zoophagus, and prey on microscopic animals, perhaps even of a simpler form and structure than themselves. They are in their turn the food of mollusca, and appear to be especially relished by *Dentalium Entale*.

With respect to Dr. Carpenter's idea that they are allied to sponges, I may remark that *Polystomella crispa* (an elegant and not uncommon species) has its periphery set round at each segment with siliceous spicula, like the rowels of a spur. But as there is only one terminal cell, which is connected with all the others in the interior by one or more openings for the pseudopodia, the analogy is not complete, this being a solitary, and the sponge a compound or aggregate animal.

I believe the geographical range or distribution of species in this group to be regulated by the same laws as in the Mollusks and other marine animals. In the gulf of Genoa I have found (as might have been expected) species identical with those of our Hebridean coast, and *vice versâ*.

In common with Dr. Carpenter, I cannot help deploring the excessive multiplication of species in the present day, and I would include in this regret the unnecessary formation of genera. Another Linnæus is sadly wanted to correct this pernicious habit, both at home and abroad.

The group now under consideration exhibits a great tendency to variation of form, some of the combinations (especially in the case of *Marginulina*) being as complicated and various as a Chinese puzzle. It is, I believe, undeniable, that the variability of form is in an inverse ratio to the development of animals in the scale of Nature.

Having examined thousands (I may say myriads) of these elegant organisms, I am induced to suggest the following arrangement:—

1. *Lagena* (Walker) and *Entosolenia* (Williamson).
2. *Nodosaria* and *Marginulina* (D'Orb.), &c.
3. *Vorticialis* (D'Orb.), *Rotalia* (Lam.), *Lobatula* (Flem.), *Globigerina* (D'Orb.), &c.
4. *Textularia* (Defrance), *Uvigerina* (D'Orb.), &c.
5. *Miliola* (Lam.), *Biloculina* (D'Orb.), &c.

This division must, however, be modified by a more extended and cosmopolitan view of the subject, as I only profess to treat of the Brit-

ish species. To illustrate MacLeay's theory of a quinary and circular arrangement, the case may be put thus.

The first family is connected by the typical genus *Lagena* with the second, and by *Entosolina* with the fifth; the second is united with the third through *Marginulina;* the third with the fourth through *Globigerina;* and the fourth with the last through *Uvigerina.*

Whether these singular and little-known animals are Rhizopods, or belong to the Amœba, remains yet to be satisfactorily made out.

4. *On the presence of Diatomaceæ, Phytolitharia, and Sponge Spicules, in Soils which support Vegetation;* by William Gregory, M.D., F.R.S.E., Professor of Chemistry, (Ib., p. 219.)—Ehrenberg, in his late work, 'Mikrogeologie,' has stated that in specimens of soils from all parts of the world, he has found many microscopic organisms; he divides these into Siliceous and Calcareous, the former including *Diatomaceæ*, *Phytolitharia*, and *Polycystina*, as well as Sponge spicules, the latter minute Mollusks and other shells. The present observations are confined to the siliceous organisms, and among these, chiefly to the *Diatomaceæ*, with *Phytolitharia* and Sponge spicules, the soils examined being such as are connected with fresh water, in which the *Polycystina* do not occur.

Many of Ehrenberg's observations were made on the small portions of soil found adhering to dried plants in herbaria, and I requested Professor Balfour to supply me with such portions of soil. By his kindness I obtained upwards of sixty such specimens, almost all of which were of very small bulk, on an average not exceeding that of a pinch of snuff, and sometimes less. Of these a certain number consisted chiefly of earth, with some half-decayed vegetable matter, and many contained hardly anything but decaying vegetable matter, with a mere trace of earth. Of course, the latter are not fair specimens of soil; but I have subjected all to the same treatment, namely, boiling with nitro-muriatic acid, washing, straining through gauze, and examining the fine insoluble residue. This, of course, contained all the siliceous matter present, but it also contained much organic matter, of a brown or red color, insoluble in acids, which, if necessary, might be destroyed by ignition, when it would leave a trifling ash.

In every case I found *Diatomaceæ* in the residue, as well as *Phytolitharia.* Sponge spicules, apparently of freshwater sponges, were less frequent, but occurred in many. In a few cases, where the acid caused effervescence, there was calcareous matter present, but in most, this was not the case.

Of course, in those cases in which the proportion of earth was small, the residue consisted chiefly of the insoluble organic matters, through which, however, Diatoms and Phytolitharia were scattered, in greater or smaller proportion.

In the cases where the proportion of earth was larger, the residue was much richer in Diatoms and Phytolitharia, but almost always contained also the dark insoluble organic matter. In several, the proportion of Diatoms in the residue was so large, that it had the appearance of a regular Diatomaceous gathering, after boiling with acids. The most remarkable soils in this respect were one from the Sandwich Islands, one from Lebanon, one from the roots of a German moss, and one from Ailsa Craig.

It is to be noticed, however, that *Diatomaceæ* were found in every case, without exception, and that in all, their proportion to the whole non-calcareous earthy residue was considerable, and often large. In many of those where the proportion of earth was smallest, there was no siliceous matter in the residue, except *Diatomaceæ* and *Phytolitharia*.

The soils examined were from various and distant localities; there were about twenty from the Andes, several from Brazil and other parts of South America, a few from North America, a few from the West Indies, one from the Sandwich Islands, one from New Zealand, a few from India, one from Lebanon, a good many from Germany, some from France, a few from Spain, and some from Britain.

The great majority of the species of Diatoms in all these were found to coincide with our British forms, but a good many species occurred in the exotic soils which have not yet been found in Britain, and most of these not even in Europe, but which have been figured by Bailey, Ehrenberg, Kützing, Rabenhorst, &c.

A good may were observed, which, so far as I know at present, have not yet been figured or described. Lastly, a certain number of species, lately found by Smith, Greville, and others, as well as by myself in Britain, and some of which are scarce, have occurred in these exotic soils. Among these I may name here, *Navicula scutelloides*, W. Sm. (Lebanon), *Orthosira spinosa*, W. Sm., Grev. (Andes, Germany), *Cymbella turgida*, W. G. (Sandwich Islands), and *Navicula varians*, W. G. (various soils).

Of such species as are unknown to Europe, I shall only mention here *Terpsinoë musica*, one of the most striking of known forms, which I found in the first soil I examined, which was from Brazil. It is accompanied by *Nitzschia scalaris*, a fine form, which occurs in Britain, but is far from frequent here.

I am satisfied that a close examination of such specimens of soil, which are often thrown away in putting up specimens in herbaria, will bring to light many new forms, and supply us with many exotic and rare species. It is very desirable that collectors of plants should preserve a little of the earth adhering to their roots, and in this way copious materials would be obtained.

The above observations entirely confirm Ehrenberg's statements as to the distribution of the *Diatomaceæ*. They furnish evidence of the fact that these organisms are far less affected by climate and temperature than larger plants or animals; since many of the very same spe-

cies are found in every latitude and in every country. For example, such common forms as *Achnanthidium lanceolatum*, *Achnanthes exilis*, *Gomphonema tenellum*, *G. constrictum*, *G. capitatum*, *Cocconeis Placentula*, *C. Pediculus*, *Cocconema lanceolatum*, *C. cymbiforme*, *Synedra radians*, *Navicula elliptica*, *N. rhomboides*, *Pinnularia viridis*, *P. major*, *P. oblonga*, *P. borealis*, *Surirella biseriata*, *S. ovata*, *Meridion circulare*, *M. constrictum*, *Cymbella maculata*, *C. scotica*, *C. cuspidata*, *Epithemia turgida*, *Ep. Argus*, *Himantidium Arcus*, *H. gracile*, *H. majus*, *Odontidium mesodon*, *Diatoma tenue*, *D. vulgare*, *Nitzschia linearis*, *N. amphioxys*, *Melosira varians*, and many others actually occur in every part of the world from whence these soils have come; and there is absolutely no difference between the exotic and the British forms.

Ehrenberg specifies two species, namely, *Pinnularia borealis* (*P. latistriata*, W. G.) and *Eunotia amphioxys* (*Nitzschia amphioxys*, W. Sm.), as having been found by him in almost every instance. My results confirm this. In no case have both of these been absent, and in at least nine-tenths of these soils both are present. They are often the predominant forms, and in a few cases almost the only forms present. *Gomphonema tenellum* and *Achnanthidium lanceolatum* are found in a large majority of these soils.

I am disposed to agree in opinion with Ehrenberg, that the microscopic organisms found in soils contribute materially to the increase of the soil. This is true both of the siliceous and calcareous forms. The *Diatomaceæ* live in moist earth. They obtain silica from the water, and at their death their shells are added to the soil. Where many are present, this process of transference of silica from the rock to the soil goes on very rapidly. We have so far evidence that they live in these soils, that we find them there very often in the state of self-division, which is not observed in old accumulations of the dead shells.

The peculiar capacity of the *Diatomaceæ* for resisting climatic changes, whereby the same species can live and thrive as well in the Arctic circle as under the line, corresponds well with the results of the study of the same organisms in the fossil state. In Ehrenberg's 'Mikrogeologie' will be found very fine figures of the Diatoms occurring in the different forms of Bergmehl, Tripoli or polishing slate, Kieselguhr, pumice, and other volcanic rocks, mountain limestone, amber, &c., and it will be seen that by far the greater number of the species are quite identical with recent ones. Microscopic organisms have been found so low down as the green sand of the Silurian system; but they rather belong to the *Polythalamia*. The earliest Diatoms, geologically speaking, as figured by Ehrenberg, agree in every point, as far as the great majority of the species is concerned, with those now living in our waters, and forming deposits which will become rock at some future time.

It was supposed that most of the species in the much more recent Bergmehl were no longer to be found living; but most of them have been since found. I myself have lately found two species of the Lapland Bergmehl to be still in existence, namely, *Eunotia octodon* and *Synedra hemicyclus*; and *Eunotia incisa*, which occurs both in the Lapland and the Mull earths, has been found recent by me in a dozen

British gatherings. Yet all these forms were supposed, not long since, to be exclusively fossil. We cannot say that there are no species exclusively fossil, but so many that have been thought so are daily found living, that it is probable the rest may be so found too, and at all events, a very large proportion of the forms in the oldest fossil deposits are absolutely identical with the forms of the present day.

I have only further to mention, that although so many species are universal in their habitat, some appear to be local. Thus, *Terpsinoë musica* does not occur in Europe, nor has it yet been found except in America, and, I think, in Australia.

Some species are decidedly Alpine; for example, *Orthosira spinosa*, which Professor Smith found on the Mont d'Or in Auvergne, and Professor Balfour on the Grampians. It occurs also in nearly every soil from the Andes.

5. *On the Injurious Effects of an excess or want of Heat and Light on the Aquarium;* by Robert Warington, Esq., (Ann. Mag. Nat. Hist., vol. xvi p. 313.)—Temperature is a point requiring great attention in carrying out successfully the principles of a permanent aquarium. The mean temperature of the ocean is estimated to be about 56° Fahr. and this, under ordinary circumstances, does not vary more than about 12° throughout the different seasons of the year. The causes of this equilibrium will be readily understood when we take into consideration the effects that must be produced by the continued flux and reflux of the tides, and by the enormous streams of water which must be flowing from the Arctic regions from year's end to year's end in one constant current, and which, by their movement, must necessarily cause other currents to flow in and take their place, thus forcing, as it were, the heated surface-water of the tropical seas towards the colder regions of the globe. Again, the whole surface of the earth, submersed below the ocean, is protected by this fluid coating from the effects of the cooling influences of radiation on the one hand, and from contact with the currents of the atmosphere on the other; and hence we perceive an always existent cause for the maintenance of a steady, equable temperature by the waters of the ocean throughout the year.

Many of the inhabitants of the sea are very sensitive to changes of temperature, and we find that a few degrees of variation will cause them rapidly to move their position and seek some cooler or warmer spot as the case may be. In the ocean it will be evident that the creatures have the power readily to effect this under ordinary circumstances, by seeking deeper water not liable to be affected by atmospheric influences, by partially or entirely burying themselves in the sand or shingle, or by shielding their bodies under the protecting shadow of the rocks or growing vegetation. In arranging the rock-work in the interior of the aquarium, therefore, great care should be taken to keep these points in view, and to afford as much protection as possible to the creatures from the cooling influences of radiation on the one hand, and from the heat of the sun's rays on the other.

From my own experience I find that the range of temperature should not be below 50° Fahr., nor above 70°; within these limits all appears to progress healthily, but beyond these points many of the creatures are rapidly affected. During the last long-continued and severe winter,

it was found very difficult, in an ordinary sitting-room having a south aspect and a good fire maintained throughout the day—the tanks being also screened at night by a blind,—to prevent the powerful cooling effects from radiation on a clear frosty night; and on three several occasions, marking exactly the three severest frosts that we experienced during the winter, the thermometer immersed in an aquarium containing about thirty gallons of water, fell as low as 45° Fahr. The Shrimp and Crab tribes, and the Crustaceans generally, are especially affected by these changes, and on each of the three occasions alluded to, one or two individuals perished; the larger-sized Prawns, as *Palæmon serratus*, appeared to suffer more readily than the *P. squilla*, although this might arise from the smaller ones being able to find a shelter from the radiation by concealing themselves more completely among the rock-work or vegetation. *Anthea cereus* is also very sensitive to considerable variations of temperature, falling from its foot-hold to the bottom of the tank apparently dead.

Excess of heat and also strong sunlight are likewise to be as carefully guarded against, and I may state as an evidence of this, that on a particularly hot day during the summer of 1854, being absent from home, the servant omitted to screen a small case from the sun's rays during the hottest period of the day, and on my return I found every creature dead. It contained an *Anthea cereus*, *Actinia dianthus*, two specimens of *Athanas nitescens*, and several others.

Too much light has also the effect of rapidly propagating several of the minute animalcules of a green color, as the *Euglena* and its congeners, which under this influence multiply so rapidly as to render the whole water of a grass-green hue; this will at times subside to the lower part of the tank as evening approaches and disappear in the shingle bottom, but immediately the morning light shines strong upon the aquarium it will rise like a thin green cloud and diffuse itself throughout the whole of the water. Although this animalcular growth is not unhealthy, yet it causes the aquarium to present a very unsightly appearance, and prevents all observation on the habits of the inmates. The want of light, I need hardly observe, causes the rapid decay of the vegetation, and the products arising from this change are highly poisonous to animal life, the whole contents of the aquarium becoming of a black color, and very soon of an offensive odor.

IV. Astronomy.

1. *Variable Star*, (Compt. Rend., 41: 950.)—Mr. Luther at Bilk has discovered a new variable star called *T. Piscium*. Its variation in magnitude is from 9–10 to 11. Its position for the equinox of 1800 was R. A. $0^h\ 20^m\ 26^s$ and Dec. $+13°\ 26'$.

2. *New Comets*, (Astron. Journ., 90.)—Mr. C. Bruhns at Berlin discovered a comet on the 12th of November, appearing like a feeble nebula. Its position at $17^h\ 22^m$ of that day was R. A. $149°\ 1'\ 26''$, and Dec. $+2°\ 7'\ 15''$, with a daily motion in R. A. of about $-20'$ of arc and in Dec. almost nothing.

On the 12th of Dec., William Mitchell of Nantucket reported the discovery, at eight o'clock on the preceding evening, of a telescopic comet in the neck of *Cetus*.

3. *Two New Planets.*—M. Chacornac, at Paris, discovered January 12, 1856, a new planet, (38) fainter than a star of the 10th magnitude. On the 8th February, he discovered another planet (39) having a brightness of a star of the 8th or 9th magnitude.

In announcing these discoveries to the Academy, M. Leverrier remarked that he was more and more convinced that a large number of small planets exists between Mars and Jupiter, and that before 1860 probably as many as a hundred will have been detected.

4. *Elements of Fides* (36) or (37), (Astron. Journ., 90.)—These elements were computed by Mr. George Rümker from the observations at Bilk Oct. 6, Berlin Oct. 23, Hamburg Nov. 2 and 13.

Nov. 0·0, 1855. M. T. Greenwich.		
Mean anomaly,	322° 17′ 40″·3	
Long. perihelion,	63 26 6 ·9	Mean equinox,
" asc. node,	8 8 56 ·2	Jan. 0·0, 1856.
Inclination,	3 11 43 ·6	
Angle excentricity,	8 22 25 ·8	
Log. semi-axis major,	0·415680	
" mean daily motion,	2·926487.	

5. *Elements of Comet* 1855, III, (Ibid.,)—Mr. George Rümker has computed the following elements from the observations of Berlin Nov. 12, Bilk Nov. 15, and Hamburg Nov. 20.

Perihelion passage Nov. 25, 66041, 1855, M. T. Greenwich.

Long. perihelion,	85° 21′ 41″	Apparent equinox,
" asc. node,	52 2 47	Nov. 15.
Inclination,	10 16 29	
Log. q.,	0·088070	

Motion retrograde.

V. Miscellaneous Intelligence.

1. *Postscript to Prof. Rogers's Paper on Binocular Vision;* by the Author.—Since the last page of this article was put to press I have seen in an elaborate memoir of Czermak, entitled "Physiologische Studien," the first clear recognition I have met with of the fact that in stereoscope vision there is necessarily an interruption of the usual relation between the axial and refractive adjustments of the eyes. Lest my illustration of this subject, in Part I . . 4 and 5, should be supposed to have been suggested by the remarks of this able observer, I deem it proper to state that this and the other chief points of Parts I and II of my memoir, having been for some time familiar to my thoughts, were communicated to the Warren Club in December, 1854, and to the American Academy, on the 31st of January, 1855. Czermak's memoir forms part of the Sitzungsberichte der K. Ac. der Wissenschaften for March, 1855. This number was issued on the 23d of May following, more than a week after my MS. was in the hands of the printer, and did not reach the Boston Nat. Hist. Soc., where I have just met with it, until the 16th of the present month, nearly eight months after my ideas on this subject were in print. I may add that it has given me much pleasure to find the views of so philosophical an observer coincident in this particular with my own. W. B. R.

Boston, Feb. 26, 1856.

2. *On a modern Submerged Forest at Fort Lawrence, Nova Scotia;* by J. W. Dawson, Esq., F.G.S., (Quart. Journ. Geol. Soc., vol. xi, p. 119.)—The extraordinary tides of the Bay of Fundy, and its wide marshes and mud-flats, are well known to geologists as affording some of the best modern instances of rapid tidal deposition, and of the preservation of impressions of footsteps, rain-drops and sun-cracks. Attention had not, however, been called to the fact which I propose to notice in this paper, that much, if not the whole, of the marine alluvium of the Bay of Fundy rests on a submerged terrestrial surface, distinct indications of which may be observed in the mud-flats laid bare at low tide, and in the deep ditches dug for drainage.

In their natural state, the alluvial soils of the Bay of Fundy are mud-flats overflowed by the high tide, and either quite bare or covered in part with salt-grass. Large tracts have, however, been reclaimed from the sea, and are distinguished by the name of "dyked marsh," or more shortly "dyke." There are in Nova Scotia 40,000 acres of dyked marsh, and in New Brunswick perhaps 10,000 acres. The soil of the marshes is everywhere a fine marine mud, deposited in thin layers by the tides, and of a brownish-red color; except in the subsoil and in the lower parts of the surface where the color has been changed to gray by the action of sulphuretted hydrogen on the ferruginous coloring matter. Though remarkably productive of grasses and cereals, no part of the marsh-land supports forest trees. Dyked and salt marshes occur in nearly every creek and inlet of the upper part of the Bay of Fundy, more especially in Minas Basin, Cobequid Bay, and Cumberland Basin; and it is in this latter that the submarine forest to which this paper refers is found to underlie the marine alluvium.

Fort Lawrence is a low point of upland, resting on Lower Carboniferous rocks, and separating the estuaries of two small streams, the La Planche and Missequash; the latter forming at this place the boundary between Nova Scotia and New Brunswick. Both of these rivers, as well as the other streams emptying themselves into Cumberland Basin, have at their mouths extensive tracts of marsh, and in this instance the marsh-land extends beyond and overlaps the upland point separating the rivers. At the extremity of the point the upland slopes gently down to the dyked marsh, beyond which there is a narrow margin of salt-marsh, scantily clothed with coarse grasses and *Salicornia*. This margin of marsh without the dyke is overflowed by the highest tides, and may therefore be taken as the high-water level. Owing to the toughness of the upper layer matted with roots, and the action of the neap tides, it presents at the outer edge a perpendicular front about five feet in height. Below this there is a sloping expanse of red mud, cut into many inequalities by the tidal currents, which appear here to be removing the old deposit rather than adding new material. On the surface of this mud I saw impressions of rain-drops and sun-cracks, tracks of sandpipers and crows, and abundance of the shells of *Sanguinolaria fusca*.* There were also a few long straight furrows, which I was told had been produced by the ice in spring. Owing to the firmness of the mud, they remained (in August) quite sharply marked, though in places filled up with new mud.

* Probably identical with *Tellina Balthica*, Linn.

At the distance of 326 paces from the abrupt edge of the marsh, and about twenty-five feet below the level of the highest tides, which here rise in all about forty feet, the mud becomes mixed with sand and gravel, with occasional large stones, probably dropped by the ice. At this level appear erect stumps and many prostrate trunks of trees. The stumps are scattered as in an open forest, and occupy a belt of 135 paces in breadth and extending on either side for a much greater distance. I saw more than thirty stumps in the limited portion of the belt which I examined. Between the lowest erect stumps and the water-level at low tide is a space of 170 paces, in which I observed only fragments of roots and prostrate trunks, which may, however, be the remains of trees swept away by the ice from the portion of the shore on which these fragments now lie.

On digging around some of the stumps, they were found to be rooted in ground having all the characters of ordinary upland forest-soil. In one place the soil was a reddish sandy loam with small stones, like the neighboring upland of Fort Lawrence. In another place it was a black vegetable mould, resting on a whitish sandy subsoil. The smallest roots of all the stumps were quite entire and covered with their bark, and the appearances were perfectly conclusive as to their being in the place of their growth. I have no doubt that the whole of these stumps have been deeply covered with the marsh-deposit, and have been laid bare by the encroachments of the tides on this somewhat exposed point. In a few places the lowest layer of the mud originally deposited over the forest soil could be observed. It is a very tough unctuous blue clay, with a few vegetable remains resembling roots of grasses. This may have been the first deposit from sea-water, while the forest was still sufficiently dense to prevent the access of coarser sediment.

All the stumps and trunks observed were pine and beech (*Pinus strobus* and *Fagus ferruginea*), and it is worthy of notice that these are trees indicative rather of dry upland than of swampy ground. The pine-wood is quite sound within, though softened and discolored at the surface. The beech is carbonized at the surface, and so brittle and soft that trunks of large size can be cut with a spade, or broken across by a very slight blow. Owing to this softened condition of the beech-stumps, they are rounded at top, and scarcely rise above the surface of the mud; while some of the pines project more than a foot. Even these last, however, are much worn and crushed by the pressure of the ice. The largest stump observed was a pine, two feet six inches in diameter, and exhibiting about 200 lines of growth.

These appearances cannot be explained by driftage, for the trees are rooted in a perfect woodland-soil; nor can they be accounted for by landslips, for the stumps are separated from the nearest upland by marshes nearly a quarter of a mile in width, and the upland is low and gentle in its slope. The popular explanation is that the tides have at some former period been dammed out, or their entrance obstructed by a narrowing of the mouth of the Bay. This theory is countenanced by the present state of the tideway of the St. John River, in which a ledge of rock so obstructs the narrow entrance, that, while at low tide there is a considerable fall outward, at half tide the water becomes level, and at high tide there is a fall inward; the level within not rising

to that of high water without, except in times of flood, when the excess of fresh water in the river supplies the deficiency of tide-water. It is evident that the complete removal of this obstruction would enable every tide to overflow ground now covered only by the annual river-floods; and, on the other hand, the river would be daily drained out to the level of the low tide. Such an obstruction would without doubt produce a change in the water-level of Cumberland Basin, and might even enable trees to flourish a few feet below the present high-water mark; but it could not under any circumstances enable upland-woods to grow nearly at the level of low tide in a country so well supplied with streams.

The only remaining mode of accounting for the phenomena is the supposition that the subsidence to the amount of about forty feet has occurred in the district. Such a subsidence is not likely to have been limited to Fort Lawrence Point; and accordingly I have been informed by intelligent persons, long resident in the neighborhood, that submerged stumps have been observed at a number of other places, in circumstances which showed that they were *in situ;* and that trees and vegetable soil have been uncovered in digging ditches in the marsh. Nor are these appearances limited to Cumberland Basin. At the mouth of Folly River, on the southern arm of the Bay, a submerged forest on an extensive scale is said to occur; and in the marshes of Cornwallis and Granville vegetable soils are found under the marsh. These facts render it probable that the subsidence in question has extended over the whole shores of the Bay, and that the marshes have been deposited and the present lines of coast-cliffs cut since its occurrence.

The marshes of the Bay of Fundy are known to have existed at or about their present level for 250 years. It is true that an opinion prevails in some of the marsh-districts, that the tides now rise higher than formerly, and in proof it is alleged that the dykes are now maintained with greater difficulty, and that tracts of marsh once dyked have been abandoned. The settling of the mud and the narrowing of the tidal channels by new embankments may, however, have produced these effects. For the antiquity of these submerged forests, we must therefore add to the two centuries and a half which have elapsed since the European occupation of the country a sufficient time for the deposition of the alluvium of the marshes. On the other hand, the state of preservation of the wood, after making every allowance for the preservative effects of the salt-mud, shows that its growth and submergence must belong to the later part of the modern period.

It is a singular coincidence that this comparatively modern instance of the submergence and burial of a forest should occur in the vicinity of the Joggins cliffs, which so well exhibit the far more wonderful events of a like character which occurred in the Carboniferous Period.

3. *Bohemian Forests and Peat-bogs;* by Dr. HOCHSTETTER*.—The primitive forests on Prince Schwarzenberg's domain, viz., at Krumau, Winterberg, and Stubenbach, may at a considerable distance be easily

* From the Proc. of the Imp. Geol. Inst. of Vienna, Jan. 23, 1855; translated and communicated by Count Marschall. Cited from Mag. Nat. Hist. [2], xvi, 378.

distinguished from the cultivated and regularly cut forests by their irregular and angular outlines; whilst the cupola-shaped summits of the firs rise considerably above the pyramidal pine-tops. Seen from an elevation, the difference between the primitive forest, with its withered tops and somewhat scattered trees, and the compact and verdant cultivated forest, is still more striking.

In some localities in the interior of the forests, the trees stand in straight lines of 150 to 200 feet [=155·55 to 207·4 English feet] in length as if planted so. Wherever the seeds do not find in the deep vegetable soil a site favorable for germination, their growth is exclusively confined to the roots and prostrate stems in a state of decomposition. Long after these stems have completely rotted away, their original length and situation are visible from the rectilinear arrangement of the younger trees, growing in the mouldering substance of the decayed veterans. This growth of the young plant on the decaying roots and stems serves also to explain the frequent occurrence of trees supported above the ground by means of exposed columnar roots, and, as it is termed, "standing on stilts."

The age of the pines and the firs in the primitive forest reaches as much as 300 to 500 years; the pines grow occasionally to 200 feet in height, and contain 1900 cubic feet [=2118·5 English cubic feet] of wood in their stem alone. One of the finest of the firs, 30 feet [=31·11 English feet] in circumference at a man's height, stood in the Brandelwald, near Unter-Muldau; it was lately blown down, and it is estimated to contain 30 klafters [=3012·03 English cubic feet] of fire-wood. Besides pines and firs, the forests in question contain beeches, maples, elms, birches, willows, and some, but very few, yew trees.

At present the extent of Prince Schwarzenberg's primitive forests is estimated at 30,000 Austrian acres [=42,660 English acres]; and the quantity of wood in them at 6½ millions of klafters [=652,606,500 English cubic feet]. A large portion of the wood from these forests is consumed in the neighborhood for the use of the glass-furnaces, and for the fabrication of musical instruments and touchwoods; but the major part is floated to the lower countries for timber and for fuel. Large quantities of the timber are sent annually to England and Hamburg for ship-building.

Rapacious animals, as bears, wolves, and lynxes, were formerly very abundant in the Böhmer-Wald, but have been exterminated. A bear, the last of its race, is supposed to be still haunting the Jokuswald, near Salnau.

The beds of peat or bituminous turf, locally denominated "Auen" or "Filze," may be considered in connection with these old forests. The whole upper part of the Moldau Valley, as far up as the neighborhood of Ferchenhaid, for an extent of 7 Austrian miles [=32·998 English miles], and with an average breadth of ¼ Austrian mile [=1·178 English mile], is one continuous peat-bed, traversed by the windings of the Moldau, whose waters assume a brownish tint by dissolving the extractive substances of the peat.

In the mountainous parts the peat-deposits are more isolated, amid surrounding forests. The dense vegetation of pumilous birches and pines covering their surfaces attests their antiquity, and points to

their analogy with the primitive forests. Lakes occur in the centre of the peat-beds near Innergefild and Ferchenhaid. A swimming island, probably owing its origin to the central swelling and bursting of the peat, is seen in the last-named locality.

Cultivation is busy converting the peat-beds into forests, meadows, and arable-fields. These deposits, however, are of great importance in the economy of nature, and it may become a question of national economy how far this cultivation may proceed without injurious consequences. The climatal and meteorological influence of the peat-beds is the same as that of the forests; they even act with more energetic and concentrated effect. By acting as natural sponges in periods when water is abundant, they attract the superfluous humidity, and so prevent inundations. In seasons of drought they give up their accumulated waters. They are the real water-reservoirs in mountainous regions; generally giving rise to the rivulets and rivers and keeping their water-level constant during every season.

4. *Fossil Footprints;* by J. WYMAN, (Proc. Bost. Soc. Nat. Hist., v, 258.)—Prof. Jeffries Wyman read a part of a memoir on the Footprints discovered by Professor Henry D. Rogers in the carboniferous strata of Pennsylvania. (*Vide* Proceedings of meeting of April 4, 1855.) He gave an analysis of the anatomical characters by which Reptiles and Fishes are distinguished from each other, and attempted to demonstrate, that although there are but few osteological characters, which, taken by themselves, are of absolute value as distinctions between these two classes, yet when the combinations of characters, which exist in any given instance, are considered, there can be but little room for doubt as to the true zoölogical affinities.

There exist no known forms of recent or fossil reptiles or fishes, which, where all their osteological details are known, cannot be referred unequivocally to one or the other of these classes. A comparison of the Ichthyoid Reptiles and Sauroid Fishes shows, that although it is through them that the two classes approach nearest to each other, yet there are no forms so completely intermediate, as to bridge over the space which separates them.

He made comparisons between the form and structure of the feet of reptiles and the fins of fishes, showing, that although they resemble each other as regards their functions, yet morphologically they are always distinct. There is no known fish, recent or fossil, the pectoral or ventral fins of which could produce a series of tracks like those discovered in the coal strata of Pennsylvania by Mr. Lea and Prof. Rogers. Although among Lophioid fishes, the pectoral fins are used for locomotion on the shores, yet they, in every instance, conform to the fish type—are fins and not feet. An analogous condition of things is found among Cetaceans and marine Saurians, where the limbs serve the purpose of paddles, and may be compared to fins, yet, morphologically, they can be referred only to the Mammalian or Reptilian types.

Prof. Wyman therefore thought, that, in the present state of knowledge, there was no ground for denying that the quadrupedal tracks found in the coal formations were made by Reptiles.

5. *On Gutta Percha tubes*, (Proc. Bost. Soc. Nat. Hist., v, 268.)—Dr. H. R. STORER reported the results of some recent experiments upon the cohesive properties of different sizes of Gutta Percha pipe, made in connection with Mr. Charles Stodder.

The first trial was with one thousand feet of a pipe, of one inch internal diameter and one and three-sixteenths external diameter, intended for an aqueduct at West Cambridge. Upon applying a pressure of 80 lbs. to the square inch, a fine hole was discovered; this hole being closed with a hot iron, a pressure of 100 lbs. was borne with ease. The remainder of the experiments were made with short pieces of pipe varying from one to three feet in length.

A piece of the same pipe was subjected to the full test; it bore 266 lbs., and burst at 272 lbs.

Another piece of the same diameter internally, with one and five-sixteenths external diameter, from a different factory, bore 300 lbs., and burst at 320 lbs.

Pipe of seven-eighths of an inch internal diameter, and one and one-eighth external diameter, stood a pressure of 280 lbs., and burst at 304 lbs.

Pipe of five-eighths internal, and one and one-thirty-second of an inch external diameter, stood 320 lbs., and burst at 360 lbs. This is the size used in Boston for the Cochituate Water, and is there subjected to a pressure of not more than 60 lbs.

Pipe of one-half an inch internal, and five-eighths of an inch external diameter, bore 234 lbs., and burst at 240 lbs.

Pipe of the same diameter but of another manufacture, intended for an ordinary pressure of 35 lbs., stood 360 lbs., and then burst.

Pipe of quarter of an inch internal, and five-eighths of an inch external diameter, stood 720 lbs., and burst at 760. This is a stout pipe, used in the shops for effervescing soda water, and generally subjected to a pressure of about 200 lbs.

Dr. A. A. Hayes asked at what temperature the experiments were made, as the power of cohesion would vary with the temperature.

Dr. Storer replied, at the common temperature of the Cochituate Water.

Prof. Wm. B. Rogers asked if these pipes were of recent manufacture. He had made experiments upon the cohesive properties of Gutta Percha and had found that a very remarkable molecular change takes place in the material after some length of time, so that it readily breaks up and becomes utterly worthless in that condition.

Mr. Charles Stodder stated that the material which had been in the market at different times was of very different qualities, and that the crude article itself, was extensively adulterated by the natives before exportation. When first introduced here and into England, much bad material was obtained. Some samples were found to be acid, and lime was recommended for its neutralization. This remedy however soon became an abuse, for lime and oxyd of zinc were at one time extensively used for its adulteration, no less than fifty per cent of lime being often introduced. Mr. Stodder has specimens of the pure gum, manufactured into different articles several years since, now in good condition.

Mr. C. C. Sheafe said he had a pipe, connected with bellows and freely suspended in the air, which had been in use about eight months, and which was now as fragile as glass.

Dr. N. C. Keep stated that he had used small quantities of Gutta Percha for several years. He had observed that when allowed to rest untouched for a considerable length of time, it uniformly lost its tenacity; but on being worked over again with the aid of heat, it appeared as tough and good as at first. The simple process of heating is not sufficient for this purpose, but the material should be re-wrought. The greatest nicety is required in determining the proper degree of heat, as brittleness may be occasioned by overheating. The use which he had made of it was in dental operations, principally as a temporary filling in sensitive cavities, etc.

6. *Army Meteorological Register for twelve years, from* 1843 *to* 1854 *inclusive;* compiled from observations made by the officers of the Medical Department of the Army at the military posts of the United States. Prepared under the direction of Brevet Brigadier General Thomas Lawson, Surgeon General United States Army. Published by authority of Hon. Jefferson Davis, Secretary of War. 764 pp. 4to., with several maps. Washington: 1855.—This large and fine volume, for which the world is indebted to the war department of our government, and to the labors especially of the medical staff of the army, and for its final elaboration to Assistant Surgeon Richard H. Coolidge, U. S. A., and his associate, Lorin Blodget, has an interest, which belongs to no similar volume hitherto published on the subject, derived from the very wide range of the continent over which its fifty-one meteorological stations extend, through the east, the west, and far west, between the meridians of 67° and 123° and latitudes 26° and 47°. The tables are not however complete for each station, through the twelve years. The volume mainly consists of tables of the observations for each month of each year, presenting those of all the stations for the same month together, and other tables giving summaries of the results for each branch of the observations, the temperature, winds, rains, etc., all of which are drawn up with fullness and evident care. There are also other tables of "consolidated tables and summaries," bringing together the results at each station. Following these tables, there are five isothermal charts of the United States, showing the mean distribution of temperature for each of the four seasons and also for the year, designed and prepared by L. Blodget. The remaining eighty pages contain a Report on the Prominent Features of General Climate in the United States, as exhibited in the distribution of temperature and of rain, and in explanation of several Hyetal or Rain Charts, made out by Lorin Blodget. As for the isothermal lines, each of the seasons, and the year also, has a separate chart devoted to it, and represents boldly to the eye the results of the observations as deduced by Mr. Blodget. Regions are shaded lighter or darker according to the amount of rain or number of inches for the season, two inches, three inches, five inches, seven inches, ten, and so on, making separate areas on the charts, and thus displaying the relative dry or wet character of different portions of the United States across the continent. More observations at a greater number of stations are required, to give full accuracy to such charts.

Dr. Coolidge, in whose hands the preparation of the work was placed, remarks in his preparatory communication, that while his own exertions have been unremitting, "the general arrangement of the tables and the grouping of the stations in climatological districts were adopted principally at the suggestion of Lorin Blodget, Esq., who has been associated with me in the preparation of the work. The isothermal and rain charts were designed and prepared exclusively by him, and he is entitled to whatever of scientific value may attach to them, and to the accompanying report explanatory of the principles upon which they were constructed, and of the results which they exhibit."

7. *The Philosophy of the Weather, and a guide to its changes;* by T. B. Butler. 414 pp. 12mo. New York, 1856, D. Appleton & Co.—The author of this new work on Meteorology has brought forward valuable results from his own observations, with regard to the clouds and winds, and reviewed the general subject of the winds and weather. We cite the following from his remarks on clouds.—

"First, then, commencing at the earth, we have what may be properly termed *fog*, or low fog. This forms, in still clear weather, in the valleys, and over the surface of the rivers and other bodies of water, during the night, and most frequently the latter part of it, and is at its acmé at sunrise, or soon after, limiting vision horizontally and perpendicularly, and dissolving away during the forenoon. It is rarely more than from two to four hundred feet in height at its upper surface, and often much less, and is composed of vesicular condensed vapor, sometimes sufficiently dense to fall in mist, and is doubtless in composition substantially what the clouds are in the other strata of the atmosphere, as observed by us, or passed through by aeronauts. I have never seen it carried up to any considerable height into the other strata by any of the supposed ascending currents, to form permanent clouds, and shall have occasion to allude to the fact in another connection. It disappears usually before mid-day, and has, when thus formed, no connection with any clouds which furnish rain.

To this Dr. Howard originally gave the name of stratus; but the latter term may be with greater propriety applied to the smooth uniform cloud in the superior strata from which the rain or snow is known to fall, and I shall retain and so apply it.

The next in order, ascending, is high fog. This is usually from one to two thousand feet in height at its lower surface. It forms, like low fog, during the night and in still weather; and is rarely, if ever, connected with clouds which furnish rain. It breaks away and disappears between ten and twelve in the forenoon, usually passing off to the eastward. This fog is most commonly seen in summer and autumn, particularly the latter, and unless distinguished from cloud will deceive the weather-watcher. It is readily distinguishable. Although often very dense, obscuring the light of the sun as perfectly as the clouds of a northeast storm, it differs from them. It forms in still clear weather, is present only in the morning, is perfectly uniform, and, before its dissolution commences, without breaks, or light and shade or apparent motion, and unaccompanied by scud or surface wind. The storm clouds are never entirely uniform or without spots of light and shade, by

which their nature can be discerned, and rarely, when as dense as high fog, without scud running under them and surface winds.

There is another fog still, connected with rain storms, but it does not often precede them; occurring at all seasons but most commonly in connection with the warm southeast thaws and rains of winter and spring; and which usually comes on *after* the rain has commenced and continued for awhile, and the easterly wind has abated; occupying probably the entire space from the earth to the inferior surface of the rain clouds or stratus. Practically this does not require any further notice. It is an *incident* of the storm. When formed it remains while the storm clouds remain, and passes off with them. It is sometimes exceedingly dense in February and March, when it accompanies a thaw, and if there is a considerable depth of snow, it has the credit of aiding essentially in its disssolution.

The next in order, ascending, are the storm scud, which float in the northeast or easterly, southeast or southerly wind, before and during storms.

These, as the reader will hereafter see, are, *practically*, very important forms of cloud condensation—although they have found no place in any practical or scientific description given of the clouds. They are patches of foggy seeming clouds of all sizes, more or less connected together by thin portions of similar condensation, often passing to the westward, south-westward, north-westward, or northward with great rapidity. Their average height is about half a mile, but they often run much lower. They are usually of an "ashy gray" color.

At about the same height, but in a *different state of the atmosphere*, float the peculiar fair-weather clouds of the northwest wind. They usually form in a clear sky, and pass with considerable rapidity to the southeast. Sometimes they are quite large, approaching the cumulus in form, and white, with dark under surface, and at others, in the month of November particularly, are entirely dark, and assume the character of squalls and drop flurries of snow; and then resemble the nimbus of Howard. They assume at different times and in different seasons, different shapes like those of the scud, the cumulus, or the stratus.

They form and float in the peculiar northwest current which is usually a fair-weather wind, and are never connected with storms. In mild weather they are usually white, and in cold weather sometimes very black, and at all times differ *in color* from the ashy gray scud of the storm."

Then follow remarks on the cumulus, stratus, and cumulo-stratus varieties of clouds. The author combats the received theories of atmospheric currents, and urges another, dependent on the magnetic character or currents of the earth and clouds. Although this theory can hardly meet with favor, the work will abundantly repay perusal and study, for the facts and comparisons he has brought out, which, if they they do not sustain his particular theory, tend to elucidate the general characters of storm regions and winds.

8. *Sixty-ninth Annual Report of the Regents of the University of the State of New York.* 392 pp. 8vo. Albany, 1856.

9. *Geological Tour over the State of New York.*—We would commend to all students who wish to acquire a knowledge of American geology, the following announcement of Col. E. Jewett of Utica, New York. He is well acquainted with all the interesting localities of rocks and fossils and has himself one of the largest collections of New York fossils that have been made. He has gone on such tours with students for several years; and last year, as well as the preceding, several joined him from Cambridge, by the strong recommendation of Prof. Agassiz. New York is the key state of the continent in a geological point of view, and no better field for study on the part of a beginner in the science could be pointed out.—Col. Jewett writes as follows:

"I propose to be at Burlington, Vermont (where any student can join the party,) on Tuesday morning the fifth of August, and begin the campaign at Port Kent opposite, on the Potsdam sandstone.—If the weather is favorable the tour can be made in four weeks. The whole expenses for each individual will amount to about one hundred dollars, while with me, my fee is thirty dollars.

A very fair collection of fossils can be made by all who wish, and the tour itself is one of the most pleasant that can be marked out. We shall visit the beautiful cañon of the Au Sable, the Thousand Isle of the St. Lawrence, the Falls of the Genesee at Rochester, Niagara falls, Portage falls, Trenton falls, and all the other principal towns and cities of northern and western New York. All who have accompanied me have expressed their pleasure and entire satisfaction."

We understand also that Col. Jewett has labeled collections of fossils and rocks to dispose of.

10. *Earthquakes in California;* by W. P. Blake.—It is well known in California that it is an "earthquake country." The name given to one of the broad indentations of the coast—*Bahia de los Temblores* (Earthquake Bay)—shows their frequency as experienced by the early settlers. I might occupy much space in recounting the recorded earthquakes that have shaken various parts of California for the last fifty years. The severe earthquake of 1812, which destroyed one of the Southern Mission establishments, is not yet forgotten by the native Californians. This, however, is not the only severe shock which has been felt, and which has destroyed life and property. According to J. B. Trask, of California, who has made a record of all the known shocks since 1812, there have been fifty-nine earthquakes during the last five years. The earthquake which occurred at Fort Yuma in 1852 was sufficiently violent to throw down a portion of Chiminy Peak, a high pinnacle of rock many miles north of the Fort. I experienced two shocks in 1854 in San Francisco, one of them sufficiently violent to awaken me by the sudden movement of the bed. A notice of this was given in Silliman's Journal. A letter just received from Dr. Trask states that "the recent shock in San Francisco occurred at 5.25 P. M., February 15th. The motion was undulatory, and at the same time vertical. Square bottles and boxes were moved horizontally, and described an arc of about 30 degrees. In some of the stores on Montgomery and other streets small articles were thrown outwards two or three feet from the south side of the walls, and those next the north walls were thrown forwards in several cases." He further states that "it was the fifth earthquake felt in the city since the 2d of January."

11. *The Mastodon giganteus of North America*, by Dr. JOHN C. WARREN. 2nd edition, 260 pp., 4to, with 31 plates, Boston, 1855.—Dr. Warren has brought out a second edition of his great work on the Mastodon. The first edition was issued, through his munificence, simply for private distribution. As there have been frequent inquiries for it by those who wished to purchase copies, he has issued this second edition. The author has made some important additions, and among them three new plates.

12. *The Canadian Journal of Industry, Science, and Art;* Conducted by the Editing Committee of the Canadian Institute; New Series, Number 1, January, 1856, 96 pp., 8vo, Toronto, Canada West.—The Canadian Journal appeared with the January Number in octavo form, and from the character of its contributors as well as the sterling value of the number issued, it is evident that it will take a high stand among the Scientific and Educational Journals in our language. Its scope is partly literary as is apparent from the names of the Editing Committee (mostly Professors in Trinity College, Toronto), as follows: Prof. DANIEL WILSON, LL.D., General Editor, Prof. E. J. CHAPMAN, in Geology and Mineralogy, Prof. J. BOVELL, M.D., in Physiology and Natural History; Prof. D. WILSON in Ethnology and Archæology; Prof. H. Y. HIND in Agricultural Science; Prof. H. CROFT in Chemistry; Proff. CHERRIMAN and IRVING in Mathematics, F. W. CUMBERLAND, C.E., and A. BRUNEL, C.E., in Engineering and Architecture.

13. *Die Fortschritte der Physik im Jahre* 1852; dargestellt von der physikalischen gessellschaft zu Berlin. VIII Jahrgang. Redigirt von Dr. A. KRÖNIG. In two parts, 8vo, of 794 pages, Berlin, 1855, George Reimer.—These two volumes contain abstracts or reviews of the various papers and works on Physics published during the year 1852, and is a whole library in a small compass. The work is prepared with great ability, being well classified, and embracing Physics in its wide range: Molecular Physics, Cohesion, Adhesion, Capillarity, Density, Mechanics, Hydromechanics, Aeromechanics, Elasticity, Fusibility, Condensation, Absorption, Acoustics, Optics in its various departments (theoretical optics, Refraction, Photometry, Polarization, Physiological optics, Chemical action of Light, Optical apparatus,) Heat with like fullness, Electricity, Physics of the Earth, (Electricity, Magnetism, Meteorological optics, &c.,) Physical Geography, (Hydrography, Orography, Volcanic phenomena,) Meteorology, etc.

14. *Annals of the Lyceum of Natural History of New York;* vol. vi, No v, 32 pp., 8vo, New York, Wiley and Halsted.—This new number of the Annals is illustrated by four finely colored plates of shells and one of a humming bird (*Mellisuga albo-coronata*, Lawrence). The contents of the number are as follows:—

Art. XVIII. F. POEY: on different points in the Natural History of Cuba, with reference to the U. S. Icthyology.

XIX. G. N. LAWRENCE: On a new Mellisuga, with a note on Trochilus aquila, Bourcier.

XX. W. NEWCOMB: Descriptions of new species of Achatinella.

XXI. T. BLAND: On certain terrestrial Mollusks of the West Indies.

XXII. E. CHITTY: On Two new species of Cylindrella, from Jamaica.

XXIII. W. A. Haines: On four new species of terrestrial shells from Siam.

XXIV. J. G. Anthony: On new species of Ancylus and Anculosa, from the Western States, U.S.

XXV. J. Gundlach: Description of a new Sylvicola.

XXVI. O. W. Morris: On the quantity of rain at different heights.

Those interested in Science, would promote the cause greatly, if they would become subscribers for the Annals of the Lyceum, the Proceedings of the Academy of Natural Sciences of Philadelphia, and the Proceedings and Journal of the Boston Society of Natural History. The annual charge is very small. The Journal of the Acad. Nat. Sci. of Philadelphia in 4to, is more costly, yet there are many through the country who would do well to science and themselves by taking it.

Officers for 1856.—*President*, Joseph Delafield; *1st Vice President*, William Cooper; *2nd Vice President*, J. Carson Brevoort; *Corresponding Secretary*, John H. Redfield; *Recording Secretary*, Robert H. Brownne; *Treasurer*, Charles M. Wheatley; *Librarian*, O. W. Morris.

Curators.—B. W. Budd, M.D., W. A. Haines, Geo. N. Lawrence, Dr. Green, R. H. Brownne.

Committee of Publication.—William Cooper, Thomas Bland, Geo. N. Lawrence, John H. Redfield, John G. Adam, M.D.

A Geological Map of Europe, exhibiting the different Systems of Rocks, according to the more recent researches and inedited materials. By Sir R. I. Murchison, D.C.L., M.A., F.R.S., &c., Director General of the Geological Survey of Great Britain and Ireland, and James Nicol, F.R.S.E., F.G.S., Professor of Natural History in the University of Aberdeen. Constructed by A. Keith Johnston, F.R.S.E., &c., Geographer to the Queen. Size, 4 feet 2 by 3 feet 5 inches. Price in sheets, 3*l.* 3*s.*; in a cloth case, 4to, 3*l.* 10*s.* William Blackwood & Sons, Edinburgh and London; and W. & A. Keith Johnston, Edinburgh.

The Microscope and its Revelations; with numerous engravings on wood. By W. B. Carpenter, M.D., F.R.S. Fcap. 8vo, cloth, 12*s.* 6*d.*

A Manual of Photographic Chemistry, including the practice of the Collodion Process. By T. Frederick Hardwich, late Demonstrator of Chemistry, King's College, London. Second edition, fcap. 8vo, cloth, 6*s.* 6*d.*

Proceedings Acad. Nat. Sci. Philadelphia, Vol. XIII, No. 1.—p. 6, Description of several species of Urodela, with remarks on the geographical distribution and classification of the Caducibranchiate division of these animals; *E. Hallowell.*—p. 11, Description of two Ichthyodorulites, *J. Leidy.*—p. 12, Synopsis of Mycetophagidæ of the United States; *J. L. LeConte.*—p. 18. Note on the genus *Lithodus* Schonherr; *J. L. LeConte.*—p. 19, Three genera of Scarabæidæ found in the U. States; *J. L. LeConte.*—p. 25, Analytical table of the species of Chlænius in the U. States; *J. L. LeConte.*—p. 29, Synopsis of the species of Chrysomela and allied genera in the United States, with a plate; *W. F. Rogers.*—p. 32, On North American birds in the collection of the Academy and the National Museum, Washington; *J. Cassin.*—p. 42, Synopsis of Entozoa and some of their Ecto-congeners observed by the Author; *J. Leidy.*—p. 59, On some extinct mammalia from Nebraska; *J. Leidy.*

Index photographed at the
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